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The World Bank

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Report No: 36367-CL

PROJECT APPRAISAL DOCUMENT  
ON A  
PROPOSED PURCHASE OF CERTIFIED CARBON EMISSIONS REDUCTIONS  
BY THE NETHERLANDS CLEAN DEVELOPMENT MECHANISM FACILITY  
IN THE AMOUNT OF A MINIMUM OF  $\square$ 2.4 MILLION  
FROM  
HIDROELECTRICA GUARDIA VIEJA S.A.  
FOR THE  
QUILLECO HYDROPOWER PROJECT  
May 31, 2006

**Finance, Private Sector and Infrastructure Department  
Argentina, Chile, Paraguay and Uruguay Country Management Unit**

**Latin America and the Caribbean Region**

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CURRENCY EQUIVALENTS  
(Exchange Rate Effective March 31, 2006)

Currency Unit = Chilean Peso (CLP)  
CLP 540 = US\$ 1

FISCAL YEAR  
January 1 – December 31

ABBREVIATIONS AND ACRONYMS

CAS	Country Assistance Strategy
CDEC	<i>Centro de Despacho Económico de Carga</i> (Economic Load Dispatch Center)
CDEC-SIC	<i>Centro de Despacho Económico de Carga-Sistema Interconectado Central</i> (Economic Load Dispatch Center-Central Interconnected System)
CDM	Clean Development Mechanism
CER	Certified Emission Reductions
CNE	<i>Comisión Nacional de Energía</i> (National Energy Commission)
CONAF	<i>Corporación Nacional Forestal</i> (National Forestry Corporation)
CONAMA	<i>Comisión Nacional del Medio Ambiente</i> (National Environmental Commission)
COREMA	<i>Comisión Regional del Medio Ambiente</i> (Regional Environmental Commission)
DGA	<i>Dirección General de Agua</i> (General Water Directorate)
EIA	Environmental Impact Assessment
ER	Emission Reductions
ERPA	Emission Reductions Purchase Agreement
GHG	Greenhouse gas
HGV	<i>Hidroeléctrica Guardia Vieja, S.A.</i>
IFC	International Finance Corporation
IRROA	Internal Rate of Return on Assets
IRROE	Internal Rate of Return on Equity
JI	Joint Implementation
MVP	Monitoring and Verification Protocol
NCDMF	Netherlands Clean Development Mechanism Facility
NPV	Net Present Value
PCF	Prototype Carbon Fund
SAG	<i>Servicio Agrícola y Ganadero</i> (Agriculture and Livestock Service)
SIC	<i>Sistema Interconectado Central</i> (Central Interconnected System)
SING	<i>Sistema Interconectado del Norte Grande</i> (Northern Interconnected System)
SVS	<i>Superintendencia de Valores y Seguros</i>
UNFCCC	United Nations Framework Convention on Climate Change
VER	Verified Emission Reductions

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**Chile**  
**Quilleco Hydropower Project**

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**Chile**  
**Quilleco Hydroelectric Project**

PROJECT APPRAISAL DOCUMENT  
Latin America and the Caribbean Region  
Finance, Private Sector and Infrastructure Department  
Private Sector and Energy Cluster

Date: May 31, 2006 Country Director: Axel van Trotsenburg Sector Manager/Director: Susan Goldmark/Makhtar Diop Project ID: P092015 Lending instrument: Certified Emission Reductions (CERs) Purchase	Team Leader: Philippe Durand Sectors: Energy, Environment Environmental category: B			
<b>Project Financing Data:</b>				
<input type="checkbox"/> Loan <input type="checkbox"/> Credit <input type="checkbox"/> Grant <input type="checkbox"/> Guarantee <input checked="" type="checkbox"/> Other: CERs purchase by the Netherlands Clean Development Mechanism Facility (NCDMF) in the amount of Euros 2.4 million between 2008-11, through yearly payments. Project financing by Colbún S.A. For Loans/Credits/Others: n/a Total Bank financing (US\$m.): n/a Proposed terms: n/a				
<b>Financing Plan (US\$m.)</b>				
Source	Local	Foreign	Total	
Colbún S.A.			79.6	
NCDMF			3.0	
Borrower: n/a Project Implementing agency: Colbún S.A. Sponsor: Hidroeléctrica Guardia Vieja S.A. (HGV) Address: Avda Apoquindo 4775, Piso 13, Santiago, Chile Contact person: Carl Weber, Gerente General, HGV Tel: 56-2-4460-4000 Fax: 56-2-460-4053 Email: <a href="mailto:cweber@colbun.cl">cweber@colbun.cl</a>				
Estimated disbursements of CERs (Bank CY/US\$m): <input type="checkbox"/> 1 = US\$1.25				
CY	2008	2009	2010	2011
Annual	0.75	0.75	0.75	0.75
Cumulative	0.75	1.5	2.25	3.0
Project implementation period: Construction 2005-07. Accredited operation: 2007-2011 Expected effectiveness date: June 2, 2006 (Date of Effectiveness of Emission Reductions Purchase Agreement, ERPA) Expected closing date (CERs purchase): December 31, 2012				
Does the project depart from the CAS in content or other significant respects?			Yes <input checked="" type="radio"/> No	
Does the project require any exceptions from Bank policies? N/A			<input type="radio"/> Yes <input checked="" type="radio"/> No	
Have these been approved by Bank management?			<input type="radio"/> Yes <input type="radio"/> No	
Is approval for any policy exception sought from the Board?			<input type="radio"/> Yes <input type="radio"/> No	

Does the project include any critical risks rated “substantial” or “high”?	<input type="radio"/> Yes <input checked="" type="radio"/> No
Does the project meet the Regional criteria for readiness for implementation?	<input checked="" type="radio"/> Yes <input type="radio"/> No
Project development objective: To provide financial support through a market-based mechanism for private investment in projects in the Chilean power sector that reduce global greenhouse gas emissions, thereby generating CERs, under the Clean Development Mechanism of the Kyoto Protocol to the UN Framework Convention on Climate Change (UNFCCC)	
<p>Project description</p> <p>The Quilleco project consists of a 70 MW run-of-river hydropower plant, located on the Laja River, 8 km downstream of the existing Rucúe hydropower plant (160 MW). The Quilleco power plant is designed for a water flow of 130m<sup>3</sup>/s taken from the water discharged from the Rucúe plant. The project will generate in average about 422 GWh per year, with a firm power capacity of approximately 47 MW. The project will feed into the Central Interconnected System (SIC) through a 0.5 km 220 kV transmission line connected to the Central Interconnected System (SIC).</p> <p>The NCDMF will purchase 100,000 tCO<sub>2</sub>e of CERs each year between 2008-2011 at a price of Euros 6/tCO<sub>2</sub>e, representing about US\$3.0 millions in total purchases. Additional CERs produced by the project (an estimated 100,000 tCO<sub>2</sub>e per year between 2008-11) will be retained by the firm Tractebel – one of Colbún’s shareholders.</p>	
<p>Which safeguard policies are triggered, if any?</p> <p>O.P. 4.01 – Environmental Assessment</p> <p>OP. 4.04 – Natural Habitats</p> <p>OP. 11.03 – Cultural Property</p>	

Significant, non-standard conditions, if any, for:

Board presentation: n/a (Project Appraisal Document to be approved by CMU Director)

Loan/credit effectiveness: n/a

Carbon finance effectiveness: ERPA effectiveness is subject to PAD approval. Carbon finance will be provided for CERs under the terms of the ERPA, based on actual electricity production.

ERPA's main covenants applicable to project implementation include the following:

- Minimum yearly generation of CERs to be transferred to the Netherlands
- Initial Verification of the project
- Full implementation of the Monitoring Plan
- Annual report on ERs
- ERs will be subject to verification and certification
- Project Entity to provide audited financial statements
- Project Entity to fully comply with the project Environment Management Plan
- Project Entity to properly insure project facilities
- Registration of project with CDM Board

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## **A. STRATEGIC CONTEXT AND RATIONALE**

### **1. Country and sector issues**

The latest Country Assistance Strategy was discussed at the Board in December 2002. It endorsed the priorities of the Lagos Administration of promoting sustainable and equitable growth and poverty reduction via a conducive, stable macro-economic policy framework, strong public institutions, investment in human capital and social protection. This agenda continues to see the private sector as the driver of employment creation and production, with the public sector facilitating that process and creating opportunities for private participation. The Bank program has focused in the three main development challenges faced by the country: (i) sustaining overall economic growth and social progress; (ii) heightening inclusion; and (ii) modernizing the state.

Chile was the first country in Latin America to implement far-reaching power sector reforms, including vertical separation of sector activities and privatization of state-owned utilities, under the principles of the 1982 General Electricity Law. The sector has a sound legal and regulatory framework and well performing regulatory and oversight agencies. Yet, due to concerns about the decreasing investment in power generation and issues of supply and demand diversification, especially in view of recent restrictions in gas supply from Argentina, the Government has introduced regulatory incentives through amendments of the General Electricity Law in 2004 and 2005 (see Technical Annex, Section 1). The project will contribute to diversification objectives in the energy sector and also supports the CAS goal of sustaining economic growth, by demonstrating the potential of new market-based approaches to support climate-friendly technologies.

### **2. Rationale for Bank involvement**

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) entered in force in 2005. It commits most industrialized countries to reduce their carbon emissions by an average of 5.2% below their 1990 levels in the period 2008-2012. The Protocol provides for domestic measures as the primary source for reducing emissions, but also created two project-based mechanisms for meeting these obligations: the Clean Development Mechanism (CDM) and the Joint Implementation (JI). The CDM has a dual purpose. It enables industrialized countries to cost-effectively meet some of their obligations through purchasing certified emission reductions from projects in developing countries, and it assists developing countries by supporting projects that promote sustainable development and access to international finance. The World Bank is one of the implementing agencies for CDM projects.

The World Bank's involvement in carbon finance ensures consistency between the Bank's policies in energy and environment, support of individual projects developed under the CDM, and contribution to the international dialogue on climate change. The World Bank also provides the ability to mobilize global experts with experience in the field, technical support for project preparation, supervision capacity, and development of linkages with other sources of expertise and funding.

The Carbon Finance Unit (CFU) of the World Bank, created to pioneer emission reductions purchase transactions through demonstrating how market-based transactions can mitigate climate



change, opens up a new source of revenue for environmentally and socially responsible projects in developing countries. The CFU supports projects that generate high quality emission reductions that are consistent with the international UNFCCC/Kyoto Protocol rules. By mobilizing the private and public sectors via a new source of project financing, the CFU is developing an important knowledge base and demonstrating how to mobilize additional resources for sustainable development that addresses global environmental concerns.

The IBRD shall acquire on behalf of the Netherlands Clean Development Mechanism Facility (NCDMF) emission reductions that have been issued by the international regulator of the CDM as Certified Emission Reductions (CERs). To be eligible to generate CERs, projects must demonstrate that they are additional as defined under the Kyoto Protocol, and that the CERs are measurable and verifiable following a methodology acceptable to the international regulator, who assesses it against the international UNFCCC/Kyoto Protocol rules. As opposed to VERs (Verified Emission Reductions) in which the buyer is exposed to the risk that the project may not be ultimately registered by the CDM Board, CERs place the carbon and delivery risks on the seller, which conversely gets a better price for ERs.

The Emissions Reductions Purchase Agreement (ERPA) defines the minimum amount of CERs in metric tons of carbon dioxide equivalent (tCO<sub>2e</sub>) that the project will deliver to the IBRD as trustee of the NCDMF. Generation and delivery of the CERs shall be carried out in accordance with a schedule set forth in the ERPA and completed on or prior to a date agreed upon between the CFU and the sponsor of the eligible project. The Quilleco project will comply with all of the above eligibility criteria.

### **3. Higher level objectives to which the project contributes**

The project will assist Chile in its long-term electricity supply strategy, stimulating and accelerating the development of renewable energy applications at the grid-connected level, under private ownership and operation. The project will contribute to the reduction of greenhouse gas (GHG) and other emissions, while responding to increasing energy demand and the need for energy diversification.

## **B. PROJECT DESCRIPTION**

### **1. Lending instrument**

There is no World Bank lending for the project, which is entirely financed by the project owner. CERs will be paid on behalf of NCDMF during project operation.

### **2. Project development objective and key indicators**

The overarching objective of the proposed project is to help mitigate global climate change by facilitating the use of market-based mechanisms sanctioned under the Kyoto Protocol through support to clean energy projects in Chile. The NCDMF, through the Bank's CFU, will purchase carbon emission reductions as they are created through renewable energy-based electricity production under a contract analogous to a power purchase agreement.

*Performance Indicators:* The primary performance indicator will be the creation and purchase of CERs, measured in tons of carbon dioxide equivalent (tCO<sub>2</sub>e). Implicit within these CERs is the production of electricity for sale to customers in the Chilean electricity market. CERs purchased by NCDMF will increase the stream of project revenues and improve the financial viability of the project. Other indicators include the satisfactory construction and operation of the project, as scheduled, and the satisfactory implementation of the EMP.

### 3. Project components

#### a) Run-of-River Hydroelectric Plant

The Quilleco project consists of a 70 MW run-of-river hydropower plant, located in the 8th region of Bío-Bío of Chile, at about 35 km east from Los Angeles and 500 km south from Santiago, on the Laja River and 8 km downstream of the existing Rucúe hydropower plant (160 MW) The Quilleco power plant is designed for a water flow of 130m<sup>3</sup>/s taken from the water discharged by Rucúe. Civil works of the project include 4.4 km of concrete channels, a 3.2 km aqueduct tunnel, a 59.4 m pressure penstock and a powerhouse with 2 sets of vertical Francis turbines and electricity generators.

With a 74% plant factor, the project will generate in average about 422 GWh per year. It will have a firm power capacity of approximately 47 MW. The project will feed into the Central Interconnected System - SIC through a short 220 kV transmission line connected to the existing 220 kV line linking the Rucúe hydropower plant and the main bus bar of the Charrúa 220 kV substation.

#### Project Details

<p><i>Physical Infrastructure</i></p> <ul style="list-style-type: none"> <li>④ 4.4 km of open channel</li> <li>④ 3.2 km aqueduct tunnel</li> <li>④ 59.4 m pressure penstock</li> <li>④ 2 sets of Francis turbines and generators</li> <li>④ 0.3 km 220 KV transmission line</li> <li>④ Construction time: 30 months</li> <li>④ Estimated cost: US\$ 79.6 million including 5% contingencies and VAT</li> </ul>	<p><i>Power plant</i></p> <ul style="list-style-type: none"> <li>④ Capacity: 70 MW (47 MW firm)</li> <li>④ Average net generation: 422 GWh/year</li> <li>④ Design flow: 130 m<sup>3</sup>/s</li> <li>④ Located 35 km east from Los Angeles city and 500 km south from Santiago</li> </ul>
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#### b) Carbon Purchases

Carbon emission reductions were estimated using the Consolidated Methodology ACM002 approved by the CDM Executive Board. Emission reductions would amount to about 1,052,000 tCO<sub>2</sub>e between September 2007 (start of project operation) and December 31, 2012.

The NCDMF will purchase 100,000 tCO<sub>2</sub>e of CERs each year between 2008-2011, at a price of Euros 6/tCO<sub>2</sub>e, for a total 400,000 tCO<sub>2</sub>e representing US\$3.0 million in total purchases. Additional CERs produced by the project (an estimated 100,000 tCO<sub>2</sub>e per year between 2008-11) will be retained by the firm Tractebel – one of Colbún’s shareholders. The amount of the NCDMF purchase includes recovery of project preparation expenses related to project appraisal, ERPA negotiation, baseline establishment, validation, monitoring, verification and certification.

Through the ERPA, the NCDMF will pay for emission reductions on delivery, providing an additional Euro-denominated revenue stream for 6 years, thus improving the cash flow and internal rate of return of the project.

#### **4. Lessons learned and reflected in the project design**

The Quilleco project is the third of its kind in Chile with WB involvement, after the Chacabuquito and Hornitos projects that were also sponsored by HGV. The successful implementation of the Chacabuquito and Hornitos projects and the operational experience and practical application of their Monitoring and Verification Protocol (MVP) have provided inputs for the design and evaluation of the Quilleco project. The project has also benefited from the experience of on-going Carbon Finance projects in Costa Rica, Colombia, Ecuador, Mexico, Peru and other countries.

#### **5. Alternatives considered and reasons for rejection**

- (i) Project alternatives such as coal or natural gas-based power plants were found less than attractive than the Quilleco project by the project sponsor, because of higher costs, uncertainty in fuel supply and/or higher environmental impacts.
- (ii) Alternatives in the design of the project itself were rejected because of their higher costs and/or potential environmental impacts.
- (iii) CERs were preferred over VERs for reasons explained in Section A.2.

### **C. IMPLEMENTATION**

#### **1. Institutional and implementation arrangements**

Chile ratified the Kyoto Protocol in April 2002. The Chilean Government has confirmed its commitment to the project in a Letter of Approval by the National Commission of Environment (CONAMA) – the Chilean Designated National Authority, dated August 31, 2005 indicating its approval that this project be registered with the CDM Executive Board. CONAMA plays an active role in the promotion of the carbon finance market in Chile, with support from the National Energy Commission (CNE) regarding energy sector projects.

The NCDMF will enter into a binding ERPA and accompanying Monitoring Protocol (MP) with HGV. The ERPA will include, *inter-alia*, the quantity, price and other delivery conditions of the CERs, and will define institutional roles and responsibilities for project implementation, as well as monitoring and verification obligations.

The NCDMF will retain the services of a fully independent, internationally-recognized third party (the Validator) to provide: (a) Validation of the sector-wide baseline; and (b) Validation of the project design, baseline (test of additionality against the sector-wide baseline), and Monitoring Plan. The Validator presents a Project Design Document (PDD) for Quilleco along with a description of the methodology chosen to measure the CERs and demonstrate project additionality, to the Executive Board of the CDM for approval and registry under international rules. A separate independent entity will be retained after one year of operation of the plant to perform the Verification and Certification of the ERs, and will produce a Verification Report covering (i) the amount of verified and certified ERs generated by the project; (ii) compliance with Bank Safeguard Policies; and (iii) compliance with requirements of the UNFCCC or the Kyoto Protocol.

The approach described above ensures the creation of an environmental commodity that is recognized by Chile's existing environment legislation and that will conform to the relevant international requirements. It is understood that some of the international requirements may change, according to decisions of the Conference of the Parties to the UNFCCC.

The project is being implemented by Colbún S.A. one of Chile's strongest power sector companies. Colbún S.A. has been involved in development, ownership and operation of large storage hydroelectric plants and run-of-river plants since 1986, including another plant (Rucúe) in the Laja River basin. Colbún S.A. has a lean and efficient organization of 273 employees, and subcontracts competitively services and works. Colbún S.A. is a well-managed company with demonstrated substantial experience in construction and operation of large hydroelectric plants, including the Rucúe run-of-river plant of similar design to the proposed Quilleco project. Colbún's environmental management system is certified according to ISO 14001.

The project will be reviewed by the World Bank during the construction and operation phases to address potential areas of implementation weaknesses, especially concerning environment and social mitigation measures contained in the Environment Management Plan (EMP), and to ensure compliance with relevant policies and procedures.

## **2. Monitoring and evaluation of outcomes/results**

Project performance is monitored as per a Monitoring Plan annexed to the ERPA and evaluated on the basis of generating the expected amount of ERs and subsequent issuance of CERs by the international validator. Monitoring the generation of ERs is implicit in the project as a function of electricity generation.

## **3. Sustainability**

The sustainability of the project is ensured by the solid experience of Colbún S.A. in designing, constructing and operating similar projects, the reasonable financial prospects for the project and the strong financial position of Colbún S.A. The project will also contribute to diversified and sustainable energy development in Chile.

#### **4. Critical risks and possible controversial aspects**

Overall the project is rated as low risk. The off-taker, country, regulatory, hydrology, financial and social risks are all rated as negligible to low. The baseline and technical risks are rated as moderate. A summary of risk assessment and mitigation measures is presented in the Technical Annex.

#### **5. Loan/credit conditions and covenants**

There is no World Bank lending associated to this project.

The ERPA to be signed between the Bank, as Trustee of the NCDMF, and HGV, specifies the rules and procedures for calculation and monitoring of ERs actually produced and includes a Monitoring Plan (MP). The quantity and price of CERs negotiated between the two parties are based on the estimates of the baseline and monitoring methodology and will be verified by an independent Validator. ERPA's effectiveness is subject to approval of this PAD by IBRD.

The ERPA key covenants related to project implementation are the following:

- Minimum yearly generation of CERs to be transferred to the Netherlands
- Initial Verification of the project
- Full implementation of the Monitoring Plan
- ERs will be subject to annual verification and certification
- Project Entity to provide audited financial statements
- Project Entity to fully comply with the project Environment Management Plan and with agreements reached with project sponsor during appraisal mission regarding social and environmental aspects
- Project Entity to properly insure project facilities
- Registration of project with the CDM Board

### **D. APPRAISAL SUMMARY**

#### **1. Economic and financial analysis**

##### **1.1 Economic analysis (baseline analysis)**

**Project additionality.** At the time when the sponsor made its investment decision in 2004, the production costs of the Quilleco project were compared to and found to be higher than both the long-run marginal cost of generation expansion of the Central Interconnected System (SIC), and the cost of alternative thermal generation. The levelized unit generation cost of the project (US\$ 24.9/MWh at 10% discount rate) was higher than the long-run marginal cost of the SIC based on gas combined cycle plants (US\$ 23.2/MWh.) Likewise it was been verified that given the small size of the Quilleco project compared with the total installed capacity of the SIC (about 7.867 MW in December 2004) and the requirements of new plants for the period 2007-2017, the project would not alter the least-cost expansion plan and can be considered as a marginal displacement plant. See Tables 1 and 2 below.

**Table 1: Generation Costs of Thermal Options (US\$/MWh)**

Thermal Option	Plant Factor	Unit Investment cost	Thermal Generation Cost (1)
		US\$/MW	US\$/MWh
Combined Cycle (NG) (2)	0.85	500	23.2
Open Cycle (NG) (2)	0.85	450	38.2
Coal	0.8	800	44.6
Diesel	0.8	300	127.1

(1) At 10% discount rate

(2) With gas prices as per existing contracts, i.e. about US\$2.8/MMBtu at plant gate

**Table 2: Quilleco Generation Costs**

Discount Rate	Capital Cost	Operating Costs	Total Annual Cost	Quilleco's Cost per MWh	Natural Gas CC alternative
	000' US\$/ year	000' US\$/ year	000' US\$/ year	US\$/MWh	US\$/MWh
10%	8,444	1,000	9,444	24.9	23.2
12%	9,882	1,000	10,882	25.8	24.3
14%	11,367	1,000	12,367	29.3	25.5

It is likely that gas prices and gas availability from Argentina will worsen in the future. However the additionality of the Quilleco Project is essentially demonstrated by the impact of carbon finance on what would be a financially marginally viable project without the sale of CERs, as shown in the following Section D1.2 (i.e. using the additionality tool methodology that forms part of ACM0002), that shows an improvement of the IRR by about 1.5% with ER credits, from about 10% without those credits.

Although project construction started in December 2004, the PIN was presented by the sponsor to the WB's Carbon Finance Unit before that date, which is evidence that the sponsor had taken into account the requested carbon financing before deciding to invest in the project.

**ERs Calculation:** The Quilleco project ERs have been estimated based on the Consolidated Methodology ACM002 approved by the CDM Executive Board, with the operating margin (OM) emission factor calculated using the Simple Adjusted Method based on actual dispatch data from the Chilean SIC. The Build Margin (BM) emission factor is calculated on the basis of most recently built power plants in the SIC that represent 20% of system generation. The baseline emission factor is the weighed average (50/50) of the OM and BM emission factors, resulting in an estimated at 475 tCO<sub>2</sub>/GWh.

Table 3 shows estimated ERs, which are used in the financial analysis presented below. Between 2007 and 2012 the total expected ERs would amount to 1.05 million tCO<sub>2e</sub>. Over a twenty-one-year period (2007-2028) the ERs would reach 4.1 million tCO<sub>2e</sub>.

**Table 3: Emission Reductions Estimates**

	2007	2008	2009	2010	2011	2012
<b>Generation [GWh]:</b>	105	422	422	422	422	422
<b>ER Estimates [ktCO<sub>2</sub>e]:</b>						
Annual	50	200	200	200	200	200
Cumulative	50	251	451	651	852	1.052

**1.2 Financial**

*Project costs and financing.* The project estimated cost is US\$79.6 million including contingencies and VAT but excluding financing charges. This cost of about US\$1,140/kW is considered reasonable for a run-of-river plant of this size and characteristics. The detailed financial analysis (see Technical Annex) shows the project cost breakdown and projected disbursements. The project will be financed by Colbún S.A. through equity inflow, which would be partly refinanced after project completion.

The projected financial cash flow for the project, under the average hydrology scenario, is summarized in Table 4. Colbún S.A. expects to contract out 287 GWh per year at an estimated node price of 29.0 US\$/MWh, and receive capacity payments of 62.5 US\$/kW-year. These node prices estimates are consistent with both official and market forecasts. Colbún S.A. will sell the remaining generation (about 128 GWh per year) in the spot market. The spot price used for the financial projections is 18.0 US\$/MWh, which is consistent with historic data and the project expected operation in the summer - when the project generates surplus energy, the system receives higher hydropower generation and combined cycle natural gas and efficient coal fired plants operate at the margin.

**Table 4: Financial Cash Flow Projections (Thousand US\$)**

<b>Without ER Sales</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>
Energy GWh	-	-	106	422	422	422	422	422
Firm Power MW	-	-	-	35	47	47	47	47
<b>INVESTMENT</b>	<b>-39.800</b>	<b>-39.800</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>INCOME</b>	<b>-</b>	<b>-</b>	<b>2.161</b>	<b>12.711</b>	<b>13.446</b>	<b>13.446</b>	<b>13.446</b>	<b>13.446</b>
SPOT ENERGY	-	-	1.469	2.210	2.210	2.210	2.210	2.210
CONTRACT ENERGY	-	-	691	8.297	8.297	8.297	8.297	8.297
CAPACITY	-	-	-	2.204	2.939	2.939	2.939	2.939
ER INCOME	-	-	-	-	-	-	-	-
<b>COST</b>	<b>-</b>	<b>-</b>	<b>-950</b>	<b>-2.800</b>	<b>-2.800</b>	<b>-2.800</b>	<b>-2.800</b>	<b>-2.800</b>
O&M	-	-	-500	-1.000	-1.000	-1.000	-1.000	-1.000
TOLL	-	-	-450	-1.800	-1.800	-1.800	-1.800	-1.800
<b>EBDIT</b>	<b>-</b>	<b>-</b>	<b>1.211</b>	<b>9.911</b>	<b>10.646</b>	<b>10.646</b>	<b>10.646</b>	<b>10.646</b>
<b>DEPRECIATION</b>	<b>-</b>	<b>-</b>	<b>-633</b>	<b>-7.599</b>	<b>-7.599</b>	<b>-7.599</b>	<b>-7.599</b>	<b>-7.599</b>
<b>OPERATIONAL REVENUE</b>	<b>-</b>	<b>-</b>	<b>577</b>	<b>2.312</b>	<b>3.047</b>	<b>3.047</b>	<b>3.047</b>	<b>3.047</b>
<b>CASH FLOW</b>	<b>-39.800</b>	<b>-39.800</b>	<b>1.211</b>	<b>9.911</b>	<b>10.646</b>	<b>10.646</b>	<b>10.646</b>	<b>10.646</b>



<b>With ER sales</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>
Energy GWh		-	106	422	422	422	422	422
Firm Power MW		-	-	35	47	47	47	47
<b>INVESTMENT</b>	<b>-39.800</b>	<b>-39.800</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>INCOME</b>	<b>-</b>	<b>-</b>	<b>2.549</b>	<b>14.265</b>	<b>15.000</b>	<b>15.000</b>	<b>15.000</b>	<b>15.000</b>
SPOT ENERGY	-	-	1.469	2.210	2.210	2.210	2.210	2.210
CONTRACT ENERGY	-	-	691	8.297	8.297	8.297	8.297	8.297
CAPACITY	-	-	-	2.204	2.939	2.939	2.939	2.939
ER INCOME	-	-	388	1.554	1.554	1.554	1.554	1.554
<b>COST</b>	<b>-</b>	<b>-</b>	<b>-950</b>	<b>-2.800</b>	<b>-2.800</b>	<b>-2.800</b>	<b>-2.800</b>	<b>-2.800</b>
O&M	-	-	-500	-1.000	-1.000	-1.000	-1.000	-1.000
TOLL	-	-	-450	-1.800	-1.800	-1.800	-1.800	-1.800
<b>EBDIT</b>	<b>-</b>	<b>-</b>	<b>1.599</b>	<b>11.465</b>	<b>12.200</b>	<b>12.200</b>	<b>12.200</b>	<b>12.200</b>
<b>DEPRECIATION</b>	<b>-</b>	<b>-</b>	<b>-633</b>	<b>-7.599</b>	<b>-7.599</b>	<b>-7.599</b>	<b>-7.599</b>	<b>-7.599</b>
<b>OPERATIONAL REVENUE</b>	<b>-</b>	<b>-</b>	<b>966</b>	<b>3.866</b>	<b>4.601</b>	<b>4.601</b>	<b>4.601</b>	<b>4.601</b>
<b>CASH FLOW</b>	<b>-39.800</b>	<b>-39.800</b>	<b>1.599</b>	<b>11.465</b>	<b>12.200</b>	<b>12.200</b>	<b>12.200</b>	<b>12.200</b>

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
<b>Cash flow (before ER)</b>	-	-39.800	-39.800	1.211	9.911	10.646	10.646	10.646	10.646	10.646	10.646	10.646
<b>Cash flow (after ER)</b>	-	-39.800	-39.800	1.599	11.465	12.200	12.200	12.200	12.200	12.200	12.200	12.200
<b>Net Present Value NPV over 30 years (before ER)</b>	<b>US\$ 2.4 million @ 10% discount rate</b>											
<b>Net Present Value NPV over 30 years (after ER)</b>	<b>US\$ 8.5 million @ 10% discount rate</b>											
<b>Estimated financial internal rate of return FIRR (before ER)</b>	<b>10.28%</b>											
<b>Estimated financial internal rate of return FIRR(after ER)</b>	<b>11.51%</b>											

Table 4 includes revenues from ERs calculated with the ACM002 methodology. The project is expected to substitute a mix of coal and natural gas-based electricity, with an average emission factor of 475 tCO<sub>2</sub>/GWh, which would result in ERs of close to 4.1 million of tCO<sub>2</sub>e for the next 21 years.

The net present value (NPV) of the project cash flow without sale of ERs is US\$ 2.4 million at 10% discount rate and US\$ 8.5 million when ER revenues are added. The project internal rate of return on assets (IRROA) is estimated at 10.3% without sale of ERs and would increase to 11.5% with sale of ERs. The project internal rate of return on equity (IRROE), assuming 50% equity and 50% debt, would be 17.6% with ERs revenues and 15.2% without ERs. (See Table 5). A sensitivity analysis shows that reasonable changes in hydrology, energy prices, ERs revenues and project investment costs do not have a significant influence on the project viability (see details in Technical Annex).

**Table 5: Financial Analysis – With and without ERs**

	<b>Without ER income</b>	<b>With ER income</b>
IRROA	10.3%	11.5%
IRROE (50% debt)	15.2%	17.62%
NPV at 10 % (US\$ million)	2.4	11.7

Although the project's rate of return might seem to be on the low side, Colbún's decision to invest in this project can be explained for a variety of reasons: (i) additional revenues generated by ERs, that were estimated conservatively; (ii) Colbún's overall strategy to increase its hydropower generation assets with low hydrology risk, to improve its generation portfolio diversification; (iii) project risks are low; (iv) project assets will continue to generate energy much beyond the project financial evaluation period; (v) some project costs are shared to some extent with Colbún's other plants in the same area; and (vi) the project rate of return is within the range of rates of return for power generation projects of this type in Chile.

### **Colbún's Past Financial Performance and Present Condition**

Historically, Colbún has held a prudent financial and investment policy and has consistently shown, a profitable financial performance, as shown in its financial statements for the last three years. Net income was US\$166.5 million in 2003 and US\$146.8 million in 2004, resulting in a ratio of net income to total assets of 10% and 8%, respectively. Operational results and earnings before depreciation, interest and taxes were stable during the period 2003 to 2004, largely thanks to stable contractual relations with Colbún's main clients: Chilectra, Codelco, Conafe, Saesa and CMPC. Accounts receivable also maintain an excellent standard. Financial statements of 2005 have not been approved yet by Colbún's Board but they confirm Colbun's strong financial performance.

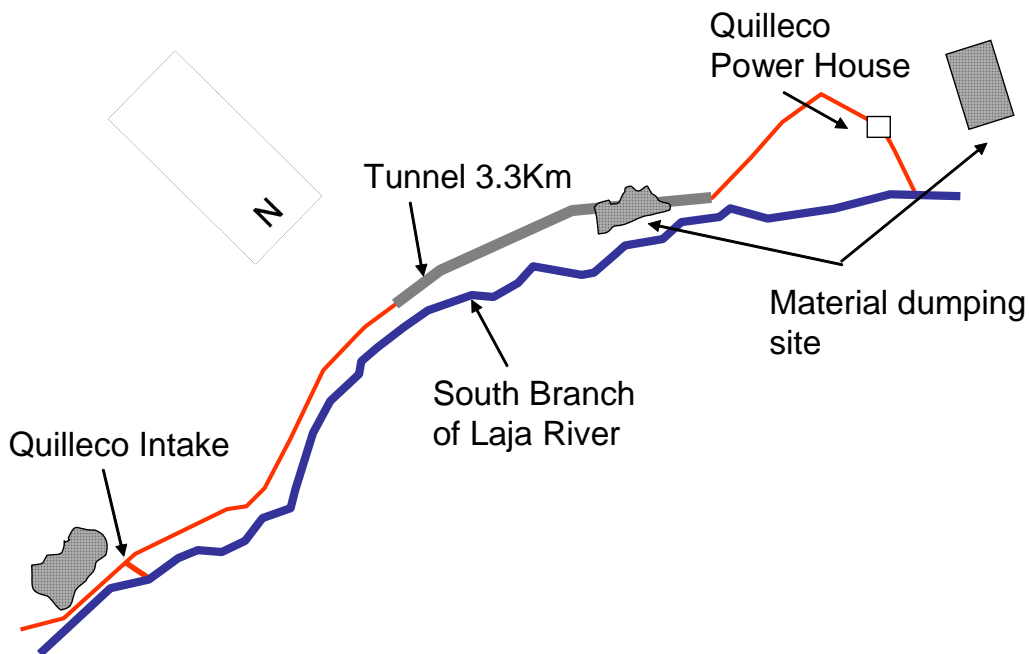
Balance sheet as of December 2004 shows total assets amounting to US\$1,853 million while total equity is US\$1,250 million or 67.5% of total assets. There are no significant guarantees on subsidiaries affecting assets of Colbún. This solid capitalization is part of the tradition of the Matte family, principal owners of the holding company, who strongly believe in maintaining a sound equity position and minimizing debt (see details in the Technical Annex).

## **2. Technical**

The technical design of the Quilleco project uses a simple layout and technologies well proven in Chile and worldwide and used in other Colbún plants. Colbún has a successful experience in the design, construction and operation of similar hydroelectric plants. The Quilleco project is composed of intake works located on the discharge channel of the Rucúe run-of-river hydroelectric plant, a system of channels at both ends of an aqueduct tunnel, a pressure penstock, a powerhouse including two sets of Francis turbines and generators, a high voltage transforming station and a short 220 kV line linked to the existing 220 kV transmission line that connects the Rucúe project with the Charrúa substation of the SIC.

All project facilities will be located on the South bank of the Laja River, downstream of the existing Rucúe hydroelectric plant. The channels, tunnel and penstock will transport a design flow of 130 m<sup>3</sup>/sec of water from the discharge of Rucúe to the Quilleco power house. The Quilleco project does not entail the construction of dams or impoundments on the Laja River or any of its branches (see schematic map of project installations below).

### Schematic map of project installations



### 3. Fiduciary

The project does not include World Bank Group financing, but the World Bank acts as Trustee of the NCDMF for payment of CERs under the ERPA.

**Payment for CERs and Flow of Funds.** The schedule of payments is based on the delivery of CERs as established in the ERPA. HGV shall make requests for payment to the NCDMF under the ERPA. The NCDMF will only pay HGV upon transfer of CERs. In the event that Quilleco fails to deliver the quantity of CERs for any given calendar year as set forth in the ERPA, the project will be required to make up for the shortfall over the course of the following calendar year or in another period as agreed with NCDMF. The involvement of the NCDMF will end when the total contracted amount of CERs has been delivered.

**Procurement.** The works and services for the Quilleco project have been procured by Colbún following its own procurement rules since there is no Bank financing. All works have been contracted with reputable firms which are currently executing 5 contracts for the construction of canals, tunnel, and powerhouse, and the supply and installation of penstocks and electromechanical equipment.

### 4. Social

The area of social analysis comprises the communes of Quilleco (direct influence area, as the project is located in this commune) and Tucapel – on the northern bank of the Laja River. The

two communes have a total population of about 22,000. Both communes have similar characteristics from a socioeconomic point of view: high levels of rural population, poverty and unemployment – compared to national average, with economic activities related to forestry, cattle breeding, informal fishing and some agriculture.

Communication and participation in the ‘Environmental Impact Study’ (EIA, *Estudio de Impacto Ambiental*) was initiated through announcements in local newspapers, as required by the EIA process established in the Chilean law (Law 19.300 and Supreme Decree 95). Several workshops and meetings took place with local authorities and community groups and unions. In these events, the Mayor of Quilleco and more recently the Mayor of Tucapel have played important roles. During the study, the process of civil participation was held from October to December 1998 through the “Open House” model, where detailed information about project scope and possible impacts at social level in the local area was made available to all interested. The EIA was approved by the environmental authorities in December 2000.

Inhabitants of the Quilleco commune showed strong support to the project, as they have benefited from jobs generated by the project. Inhabitants of Tucapel were less supportive of the project, because some inhabitants living on the northern bank of the Laja River claimed that the construction and operation of the Rucúe plant reduced water availability, resulting in the drying out of several river branches and impacts on water wells, pastures and fishing. These inhabitants feared that the Quilleco project would exacerbate issues of water availability, as it will use the water discharged by the Rucúe plant. The annual independent environmental monitoring of the Rucúe project conducted between 1998-2002 by EULA, University of Concepción, showed that the minimum ecological flow (MEF) was sometimes below levels established in the Rucúe EIA, which, combined with extreme drought periods (specially in 1998), might explain the above noted impacts. The views of Tucapel authorities towards the project have significantly improved after the 2004 municipal elections, which resulted mainly from the provision of relevant information and proactive communications of Colbún S.A. with the Mayor of Tucapel. The key element for water availability downstream from the water intake (i.e. maintaining the agreed upon MEF) will be monitored through multi-point measuring, to be conducted by an independent auditor twice a year – the results of which will be communicated to local authorities.

Although Colbún S.A. does not have an explicit corporate social policy, it indeed promotes several social and cultural activities in the regions where it has power projects. That is also being done in the case of the Rucúe and Quilleco projects. For example, measures have been taken to ensure job generation in local communities. Over 600 local jobs have been created during the construction phase of the Quilleco project, which are benefiting the local communities of Antuco, Quilleco, Tucapel, Los Angeles and Huepil. The employment plan and related training of 10 percent of manpower hired, has been successfully developed in coordination with the municipal authorities. Moreover, Colbún has agreed to carry out a communication and information plan with the local community of Valle del Laja (about 25 families which had claimed a decrease of water availability during the 1998 drought) and to support the financing of sustainable productive activities and social actions intended to benefit the people of Quilleco and Tucapel communes.

The project will not cause resettlement of population nor will the open aqueduct have an impact on economic activities. Land to be occupied by project installations (aqueduct, power house, water intake, three material dumping sites) belong to five land owners, with whom Colbún S.A. has agreed upon specific compensation. Subject to maintaining the established minimum ecological flow in the river, the project will have no impacts on any population living near the project area. The channels and tunnel will not produce significant impacts on landscape value. During project construction and operation, the mitigation, reparation and compensation measures included in the EIA adequately address atmospheric emissions, noise generation, deforestation, security and emergency management, cultural patrimony and landscape alterations caused by the project.

Regarding archeological patrimony, the EIA detected one site of significant cultural patrimony value in the area of direct influence of the project. The site was identified and isolated to prevent damages during the construction phase. The EIA has included adequate procedures if other archeological sites are found, which has not been the case so far.

## **5. Environmental**

***Environmental Baseline.*** The EIA covers all relevant environmental aspects with a detailed environmental baseline analysis of the project and a description of its area of influence, pointing out every single impact of geophysical, ecological and social nature. It also includes the legal aspects affecting the project. Relevant aspects of the environmental baseline include a relative poor local terrestrial and aquatic flora and fauna, with few aquatic species under different degrees of protection, for which specific and suitable protection measures are considered.

Nevertheless, in early 2005 Colbún S.A. contracted with EULA of University of Concepción, on a voluntary basis, an additional baseline assessment in order to compare the current situation (before project operation) with the 2004 situation. The report concluded that population of invertebrates and fishes are comparable to those observed in 2004 (composition, quantity and habitat use). It was found that total and fecal coliform concentrations were higher in 2005 than in 2004, particularly in the lower downstream part of Rucúe River (not associated to Quilleco project construction).

It should be noted that the Quilleco project is less environmentally sensitive than the Rucúe project because: (i) the environmental regulations and their enforcement have improved since 1996; (ii) Quilleco's baseline is less environmentally and socially sensitive than Rucúe's; (iii) Colbún has now a certified ISO 14001 Environmental Management System, which is applied to both Rucúe's operation and Quilleco's construction..

***Environmental Impacts.*** Impacts of the project during the 3-year construction phase include: dumps for tunnel excavation material; noise due to use of explosives for tunnel construction; some degree of water pollution associated to riverbed works (suspended material of the river ground); generation of solid waste; and minor atmospheric emissions from transport and machinery operations. Risk of hydrocarbon spills and electromagnetic radiation from inspection of welds are also described in the EIA. Each of those risks and impacts are well defined and specific control and mitigation measures are being enforced. Contractors must apply

environment measures as specified in their contracts. Material dumping sites were established (see schematic map on page 14) and are being adequately managed during construction.

During project operation, the Minimum Ecological Flow (MEF) is the most important environmental provision to ensure water availability and quality and to protect natural habitats and fish species. EULA of University of Concepción played an important role in the study and determination of the MEF in the area of influence of the Quilleco project. The conservative In-stream Flow Increase Methodology (IFIM) was used by EULA for the first time in Chile for MEF determination. Criteria of this methodology include landscape, habitat and biodiversity (algae, invertebrates and fish) conservation. Special emphasis was given to the enforcement of measures intended to avoid the extinction of endangered fish species (*D. nahuelbutaensis* and *P. irwini*) and vulnerable species (*T. areolatus*, *P. trucha*, *B. australis*, *C. galusdae* and *O. mykiss*). *O. mykiss* and *P. trucha*, which are introduced fish species and have economic value associated to fishing activities). In October 2002 COREMA approved a MEF of 6m<sup>3</sup>/s for a two-km zone of the Laja River south branch located downstream from the point where the Quilleco project will have its water intake (it is the same point where Rucue now discharges its water to the Laja River). In accordance with recommendations made by EULA, the MEF should be monitored permanently by Colbún at three points within the area of influence of the project and the results of the monitoring results must be audited twice a year for 5 years.

**EIA Approval.** A thorough EIA process was executed in 1998-2000 and COREMA issued a favorable Environmental Qualification Resolution for the Quilleco project on December 16, 2000. This resolution was amended in January 2001 to account for some minor omissions. During the EIA, Colbún S.A. was officially asked to clarify technical and legal aspects related to environmental impacts. All of them were reviewed and approved according to COREMA requirements. All relevant authorities designated by COREMA participated formally during the EIA process, and did not oppose the project. Additional conditions regarding mitigation, reparation and compensation measures were taken into account in the environmental approval resolution.

**EIA implementation.** Colbún S.A. has set up an Environmental Project Committee in charge of the management and coordination of the environmental aspects of the Quilleco project in accordance with procedures of the ISO 14001 certified Environmental Management System of Colbún S.A. Environmental impacts of the Quilleco project are well defined and were adequately assessed by environmental and sector authorities. Communications among the local environmental authority (COREMA), Colbún's environmental consultants (EULA), Colbún staff and the World Bank specialists were fluid and well documented. All necessary permits were granted and contractors for the construction phase are well informed about environmental management and EIA commitments. Contractors are applying their own strict environmental standards in general as well as specific ones applicable to the Quilleco project, as included in their contracts.

Six EULA quarterly reports on project construction monitoring up to March 2006 present evidence of satisfactory application of mitigation measures, appropriate work safety measures, controlled landscape aspects according to specifications, and adequate waste management. No adverse effects on local communities or private property were observed. Erosion risk is under

control and material deposited on dump sites is covered with a layer of fertile earth for planned re-vegetation. Slopes are being managed according to the EIA. As of March 2006, revegetation of dump sites and slopes is clearly observed. It has been done since the beginning of construction.

In August 2005, EULA issued a report on Quilleco Reforestation and Re-vegetation Program, concluding that this program satisfies EIA commitments. It recommends the use of local species to ensure landscape conservation, and additional reforestation measures.

During project appraisal the following additional measures were agreed upon with Colbún and referred to in the ERPA:

- Colbún will send the quarterly reports on environmental and social audits to the Bank.
- The Bank will carry out a mission to evaluate the implementation of the environmental management plan before the end of project construction.
- Colbún will support research and scientific publications on endangered fish species of the Laja River in the area of influence of the Quilleco project.
- Colbún will expedite ongoing measures intended to address the environmental liabilities of Rucúe project.
- Colbún will implement a communication and information plan with the Valle de Laja community on the environmental impacts of Quilleco project and will inform the Bank on the results of this activity.
- Colbún will establish a baseline of the environmental situation in the Valle de Laja community.
- Colbún will support the implementation of small productive and social projects as a contribution to the economic and social development of the area.
- Whenever necessary, Colbún and COREMA will jointly analyze the possibility of establishing a three-party committee (Colbún, COREMA and Communities) as a mechanism to resolve possible conflicts with the communities regarding environment and social aspects.

**Conclusion.** The B environmental rating is confirmed for the Quilleco project, considering the limited sensitivity of environmental baseline, the adequate EIA consultation and approval process and the relatively insignificant impacts of the project, for which specific and adequate protection and mitigation measures have been defined, including additional measures that were discussed and agreed upon during project appraisal (see Section 11 of Technical Annex with detailed information on the environmental baseline, analysis, impacts and mitigation measures for the project). The independent environmental audit reports are available in the project files (also see the EIA and Environment Management Plan in the WB InfoShop).

## **6. Safeguard policies**

The World Bank safeguard policies that are triggered by the project include Environmental Assessment, Natural Habitats and Cultural Property. A summary analysis is presented below.

O.P. 4.01 – Environmental Assessment  
Risk Level: LOW

Site sensitivity to project implementation and operation can be classified as low to medium. Downstream of the influence area of the project, the water flow used for agricultural purposes will not be affected. A minimum ecological flow of 6m<sup>3</sup>/s will be ensured in the sensitive first two kms of the Laja River south branch, downstream from the Quilleco project water intake. Erosion risk is low, since general geomorphology of the influence area is rocky. The project will not cause involuntary resettlement and no indigenous people will be affected. Specific and suitable protection, mitigation and monitoring measures are clearly defined in the approved EIA. Independent monitoring and control of application of the EIA measures is taking place during project construction and will continue during project operation.

#### OP. 4.04 – Natural Habitats

Risk Level: LOW

Endangered fish species were identified within the area of influence of the project, and protective measures were defined in order to protect its habitats, in particular through application of the minimum ecological flow, which will be subject to monitoring and auditing. During project appraisal, Colbún committed to support additional activities such as research on fish population management and publications on endangered fish species.

#### OP.11.03 – Cultural property

Risk level: LOW

With respect to cultural property, one archeological site was found in the area of influence. Protection measures have been implemented for this particular case. This area will not be affected by construction activities or dump sites. Contingency measures for other possible findings are clearly defined in the EIA and local authorities are officially informed. The National Monument Law applies in case of other findings: sponsor must stop works immediately and inform local authorities about findings, who will assess each finding on a case by case basis. The probability of further findings seems low.

### **7. Policy Exceptions and Readiness**

There are no policy exceptions and the final ERPA is ready to be signed.

The engineering design documents were completed and award of all contracts for project construction has been done by Colbún S.A. Construction works started in December 2004 and commercial operation is planned to start in September 2007 in accordance with a realistic implementation schedule.



## TECHNICAL ANNEX

### 1. Country and sector or program background

#### *Power Sector Background*

Chile has a modern and developed electric industry, a sound legal and regulatory framework and well established regulatory and oversight agencies. It was the first country in Latin America to implement far-reaching power sector reforms, including vertical separation of sector activities and privatization, under the principles of the 1982 General Electricity Law. Subsequently, the Chilean power sector has served as a model for sector reforms and privatizations in the LAC region. The Chilean power sector is currently characterized by an unregulated competitive generation market (with no entry restrictions), open access to transmission and distribution networks, and private participation at all levels. In March 2004, the 1982 General Electricity Law was amended by Law No. 19.940 in order to strengthen market forces in the operation of the sector and to improve transmission regulation.

#### *Sector structure*

The national electrical network is divided into four systems (two large systems in the north and the center and two small systems in the south, see figure A1). The northern system (*Sistema Interconectado del Norte Grande – SING*) comprises 31% of the total installed capacity, but only 5.6% of the population. The majority of clients are large industrial complexes (mainly mining companies). The generation is almost exclusively thermal. The central interconnected system (*Sistema Interconectado Central – SIC*), to which the proposed project will be connected, contains 698% of installed capacity, but over 90% of total population of Chile. The current installed capacity in the SIC reaches 8,288 MW, of which about 57% are hydro plants and 43% are thermal plants (see Table A.1). Interconnection of the northern and central systems would help to balance existing excess supply in the north with the fast-growing demand in the central system. The earliest realistic date when the interconnection of the two systems can be accomplished is 2008.

**Table A.1: Installed Power Capacity–December 2005**

MW	SIC	SING	OTHERS	Total
Thermoelectric	3,593	3,583	79	<b>7,255</b>
Hydroelectric	4,695	13	20	<b>4,728</b>
<b>Total</b>	<b>8,288</b>	<b>3,596</b>	<b>99</b>	<b>11,983</b>

Source: CNE

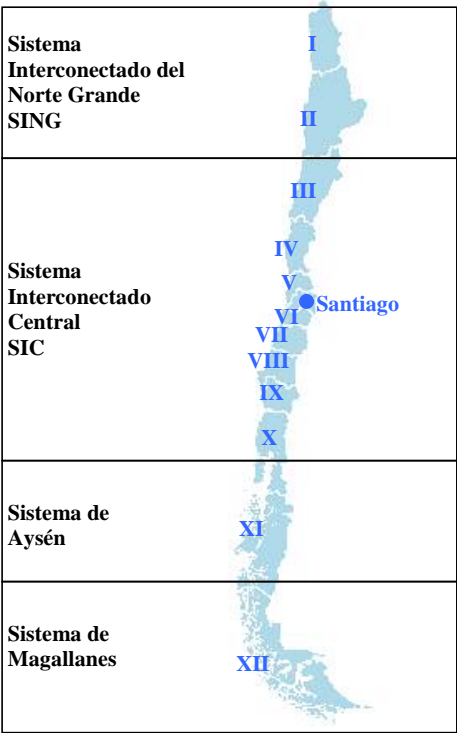
In each of the large systems (northern and central), the load dispatch center (*Centro de Despacho Económico de Carga – CDEC*) is responsible for planning and coordinating load dispatch. The Law establishes the obligation to optimize generation and thus, load dispatch reflects economic merit order for the corresponding system, based on marginal costs of each unit. Generators receive payment for available capacity and for actual energy delivered. They can sell power via negotiated contracts with distributors and large unregulated consumers and/or make power available to the system's spot market. Prices to be charged by generators to distributors

correspond to the weighted average of projected marginal costs of the system and are calculated by the National Energy Commission (*Comisión Nacional de Energía – CNE*) for different nodes in the transmission system (node prices). Prices to unregulated consumers are freely negotiated. In the spot market, prices are determined by the marginal cost of the system, i.e. the cost of the most expensive unit dispatched, on an hourly basis. There are no restrictions to market entry for generators. All current and prospective generators make their own judgments and take their own risks on amount of capacity to be installed, technology, fuels and site locations, based on their perception of demand growth, the evolution of capital and fuel markets, and any other parameters that may influence their businesses, in application of environmental regulations and other permits. Overall, installed generation capacity has kept pace with electricity demand growth, with adequate reserve margins.

Distribution and transmission are regulated. Distribution companies have an obligation to provide service in their respective concession areas, with maximum tariffs set by the regulatory agency. Transmission companies have to guarantee open access to their network for all generators, under regulated price.

Currently 26 generation, 5 transmission, and 36 distribution companies are operating in Chile, all of them private.

**Figure A.1: Chile’s Four Electrical Systems**



## ***Sector Institutions***

### ***(i) Kyoto-related institutions:***

**CONAMA:** (*Comisión Nacional del Medio Ambiente*) is the national institution responsible for environmental issues in general, including in the power sector. Its responsibilities include administration of the environmental impact evaluations, development of environmental norms and oversight of the compliance with these norms.

**COREMA:** (*Comisión Regional del Medio Ambiente*) is the regional institution, depending from CONAMA, responsible for addressing the environmental issues in the corresponding Region. It administers the evaluation of the environmental impact of its regional projects and oversees the compliance with the national environmental norms.

### ***(ii) Other institutions:***

**CDEC:** There is an economic load dispatch center (*Centro de Despacho Económico de Carga*) in both the SIC and SING systems, which are private, independent entities, composed of representatives of generation and transmission companies. The CDECs ensure the optimum operation of the system, based on lower marginal costs, and determine values of economic transactions carried out between companies.

**CDEC-SIC:** The CDEC-SIC operates in the Central Interconnected System. Colbún is a member of the CEDEC-SIC through its largest generation plants, but not through the Quilleco project (as membership is obligatory only for generators with capacity above 2% of the total installed capacity in the whole SIC). All generating plants supplying electricity to the system, including the Quilleco project and other power plants, are under CDEC-SIC operating supervision and coordination. CDEC-SIC will play an important role in the monitoring of ERs by providing the data necessary to recalculate the OM and BM emission factors every year.

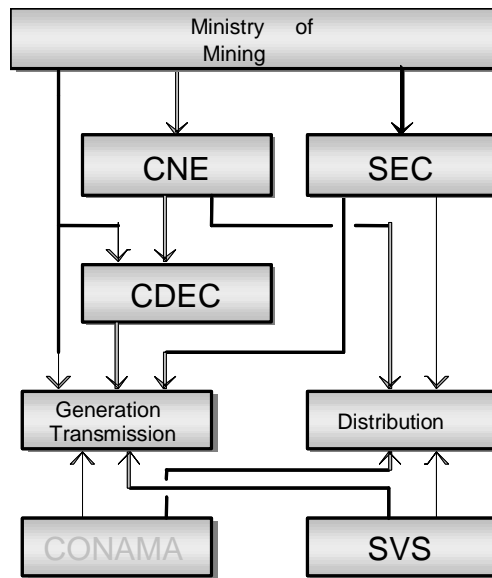
**CNE:** The sector is regulated by an autonomous agency, the *Comisión Nacional de Energía* (CNE). Its main responsibilities for the power sector include (i) proposing sector norms and regulations; (ii) coordinating planning, policies and norms for efficient functioning of the market; and (iii) calculating and enforcing regulated prices.

**Ministry of Mining:** In the power sector, the Ministry of Mining chairs the CNE and is responsible for (i) setting distribution tariffs and node prices (based on CNE's calculations), (ii) resolving possible conflicts among the members of the CDECs, and (iii) awarding concessions.

**SEC:** The *Superintendencia de Electricidad y Combustibles* is responsible for supervising compliance with existing laws, regulations and technical norms related to the generation, production, storage, transport and distribution of liquid fuels, gas and electricity.

**SVS:** The *Superintendencia de Valores y Seguros*– is an independent entity, related with the government through the Ministry of Finance. It oversees companies involved in stock market and insurance business.

**Figure A.2: Power Sector Institutional Diagram**



### *Government strategy*

The sector reforms conducted in the 1980s were successful in setting the ground for a continuous, private sector-led expansion of the generation capacity, as well as transmission and distribution networks, capable of keeping pace with fast electricity demand growth of 7.0% per year in the SIC and 15.4% per year in the SING over 1995-2003 (source: www.cne.cl).

Nevertheless, after almost 25 years of successful sector performance, the regulatory system required certain adjustments to provide further incentives for capacity expansion, strengthen market forces and improve transmission regulation. These aspects have been addressed by Law N° 19.940 enacted on March 13, 2004 and Law 20.040 of June 2005 that amended the General Electricity Law on the following topics:

#### (i) Strengthening market forces in the operation of the sector

The market signals in the operation of the system were still relatively weak, particularly in the central system where the proportion of unregulated consumers is relatively low (33% of demand in the SIC). The March 2004 amendments to the General Electricity Law put into effect the Government's strategy to foster competition with new rules that include: (a) reducing from 2,000 kW to 500 kW the threshold for unregulated consumers; and (b) improving regulation of commercialization activities, including measures to improve access to distribution networks for all generators.

#### (ii) Promoting capacity additions to the power system

There were concerns about the decreasing trend of investment in power generation and in view of the fast electricity demand growth and uncertainties in gas supply from Argentina, the June

2005 amendments to the General Electricity Law addressed these issues by: (a) reducing to +/- 5 % the margin of unregulated consumer's prices, around which node prices can be determined by the CNE (in order to better reflect market-like conditions); and (b) stimulating small projects up to 9 MW of capacity, which will not require transportation fees any longer.

(iii) Improving transmission regulation

The March 2004 amendments to the General Electricity Law introduced modifications to regulation and pricing of transmission in order to ensure adequate investment in transmission and facilitate interconnection between the northern and central systems.

The unexpected reduction in 2004 and 2005 of natural gas supply from Argentina (up to about 30 percent reduction during some periods) has raised concerns about impacts on electricity costs and supply security. The reduction in natural gas supply has mainly affected industries but it has not affected the operation of natural gas-fueled combined cycle power plants that can switch to diesel fuel, nor steam power plants that can switch to coal. However, a permanent reduction in natural gas supply would result in higher power generation prices and provide incentives for investment in hydroelectric and coal-fired power plants.

**Power sector environment impacts**

Environment impacts continue to present important challenges for the power sector, as a large proportion of the electricity generated still comes from highly polluting coal-fired plants, even though these are being slowly displaced by more efficient and less expensive technology based on natural gas combined cycle plants. In 2003, coal-fired plants generated 3,070 GWh in the SIC, i.e. 9.1% of the total energy generated in that system. In 2004 this figure was slightly higher with 4,278 GWh of coal generation, i.e. 11.8% of the energy generated in the SIC (see table A.2). Coal based generation was even higher over the period 1997-99 due to a severe drought. That level of electricity generation from coal-fired plants releases to the air about 3,500,000 tCO<sub>2e</sub> per year. Other pollutants from power plants include SO<sub>2</sub> and NO<sub>x</sub>. This situation is unlikely to change in the near future, as coal-fired power plants are expected to be needed to meet the high demand for electricity that would grow at a rate of about 8% per year during the next decade.

**Table A.2 - SIC Coal-fired Energy Generation and CO<sub>2e</sub> Emissions in 2002, 2003 and 2004**

PLANT NAME	Op. Date	Emission factor tCO <sub>2</sub> /GWh	Energy Generation (1)			CO <sub>2</sub> Emissions (2)		
			2002 GWh	2003 GWh	2004 GWh	2002 tCO <sub>2</sub>	2003 tCO <sub>2</sub>	2004 tCO <sub>2</sub>
GUACOLDA 1	1995-96	872	489	1.213	1.234	426.514	1.058.435	1.076.390
GUACOLDA 2		872	476	1.227	1.235	415.648	1.069.944	1.077.421
HUASCOTV	1965	1.841	-	-	4	-	-	7.561
VENTANAS1	1977	1.063	-	31	413	-	33.137	439.590
VENTANAS2	1964	1.017	-	388	1.051	-	395.008	1.068.851
LAGVERDE	1939-49	2.178	-	-	39	-	-	83.902
RENCA	1962	1.151	1	0	3	855	18	3.239
BOCAMINA	1970	922	-	211	300	-	194.159	276.590
<b>TOTAL</b>			<b>966</b>	<b>3.070</b>	<b>4.278</b>	<b>843.016</b>	<b>2.750.701</b>	<b>4.033.543</b>

Notes:

(1) Data from CDEC-SIC annual reports

(2) Emission factor estimation from IPCC manual and CNE node price report

## **Carbon finance in Chile**

CONAMA is playing an active role in the promotion of and information on the carbon finance market in Chile, with support from the CNE regarding energy sector projects. A large portfolio of projects has been identified or implemented in several sectors, including power generation (Chacabuquito, Hornitos, Quilleco, La Higuera, others), transport (Transantiago), landfills (Loma Los Colorados), energy efficiency (buildings, commercial sector), agroprocessing (milk, etc.), composting (Maipu) and forestry (Forestal Terranova).

### **Sector issues to be addressed by the project and strategic choices**

The objectives of the project are to generate ERs and to contribute to finding market-based solutions for the mitigation of environmental impacts of the power sector in Chile. Specifically, the electricity produced by the Quilleco project will replace electricity produced by thermal plants, particularly by highly polluting coal-fired plants, resulting in ERs of about 200,000 tCO<sub>2</sub>e per year.

The project is also expected to have demonstration effects in the Chilean power sector and other countries. Specifically, following up on the Chacabuquito and Hornitos hydropower projects, it is expected that the Quilleco project will strengthen government and private sector understanding of how to take advantage of the opportunity to achieve and sell ERs in the framework of the Kyoto Protocol and the UNFCCC. The project is expected to generate incentives for implementation of similar projects in the future, contributing to the reduction of greenhouse gas emissions in Chile and worldwide.

## **2. World Bank Carbon Finance projects in LAC**

Currently, the World Bank Carbon Finance Unit (CFU) has over twenty carbon finance projects in the LAC Region that are under preparation or operation. Many of them utilize hydro or wind power, although cogeneration, biomass, geothermal, solid waste management, and gas flaring reduction technologies are also represented.

The first carbon finance project in the LAC Region with an Emissions Reductions Purchase Agreement (ERPA) and the third such project in the Prototype Carbon Fund's (PCF) history was the Chacabuquito Hydropower project in Chile. Chacabuquito is a 25 MW run-of-river hydro power plant. Its annual average generation of 175 GWh replaces coal and natural gas-based electricity that would otherwise produce greenhouse gas emissions. The project entails a purchase of ERs for the PCF valued at US\$6.7 million over the next 14 years (see Box A.1).

The Brazil Plantar project is the second one that was negotiated in the LAC Region, and involves the purchase of US\$5.3 million in ERs. The project will substitute coal as fuel in pig iron production, with high energy-content charcoal from sustainable biomass. The project is unique in that it also involves additional forestry activities that will offset carbon.

The Chile Hornitos project was negotiated in 2004 and is now under construction. The Hornitos project is a 55 MW run-of-river hydro power plant. Its annual average generation of 175 GWh

will replace coal and natural gas-based electricity that would otherwise produce greenhouse gas emissions. Under the ERPA, the NCDMF will purchase an average of 167,000 tCO<sub>2</sub>e/year of CERs in each of the first 6 years of the project operation, valued at □4.15 million.

The Costa Rica Umbrella Project for Renewable Energy Resources is under advanced preparation, and currently includes three small-scale sub-projects – two wind-farms and one hydro power plant, that will result in over US\$2 million in ERs.

Colombia Jepirachi Wind Farm is a 20 MW wind project in the North East of Colombia. It will displace 68.3 GWh of coal and gas energy for a purchase of US\$3.5 million ERs while bringing significant economic and social benefits to local indigenous people.

Colombia Rio Amoya Environmental Services Project is a recently-approved project that uses part of the carbon credit revenues from a new 80 MW run-of-river hydro plant for environment management in a protected natural area and to promote social plans for the local communities.

Mexico INELEC Umbrella of Hydro Projects includes several small run-of-river hydro plants developed by private sponsors in Mexico as a first-of-a-kind carbon finance experience in the country, which the World Bank was instrumental in developing.

Peru Poechos 15.4 MW hydropower plant, recently approved, will displace 60 GWh per year and reduce CO<sub>2</sub> emissions from thermal generation by 350,400 t in 10 years.

### Box A.1 Experience of the Chacabuquito Run-of-river Hydropower Project



The Chacabuquito project was successfully built by HGV as scheduled and within budget. Its operation since July 2002 has been without problems. Actual carbon emission reductions are very close to initial estimates.

Project estimated cost: **US\$ 37.0 million**

Project actual cost: **US\$ 35.5 million**

Actual completion: **July 2002**

Million tons	2002	2003	2004	2005(2)
Estimated ERs	60,000	137,000	137,000	79,916
Actual ERs (1)	46,031	132,927	141,639	75,451

(1): Figures presented for each calendar year. However ERs are validated for each twelve month period from June to May.

(2): ERs in 2005 are only accounted until August.

The environment and social management plan is being implemented as per its terms, in particular, maintaining an ecological flow of 3m<sup>3</sup>/s, though with some difficulties regarding the reforestation program.

Other projects in the CFU's LAC pipeline include: hydropower projects in Ecuador; wind and hydro power plants in Honduras; hydro and geothermal in Guatemala; wind power, gas flaring reduction and sugarcane bagasse cogeneration in Mexico; biomass and solid waste management in Brazil; bagasse cogeneration in Guyana; wind farms in Jamaica and landfill projects in Argentina. New project ideas from the region are being received by the CFU nearly every week.

### **3. Results framework and monitoring**

The project results will be measured within the framework established in the Emission Reductions Purchase Agreement (ERPA) between HGV and NCDMF/World Bank, including the Monitoring and Verification Protocol (MVP).

### **4. Detailed project description**

The Quilleco Project sponsored by HGV and being developed by Colbún S.A., a Chilean private power company, is a 70 MW run-of-river hydropower plant that utilizes the water discharged by the existing 160 MW Rucúe hydropower plant (130m<sup>3</sup>/sec). Quilleco is located in the 8th region of Bío-Bío of Chile, at about 35 km east from Los Angeles city and 500 km south from Santiago. All project facilities are sited on the South bank of a branch of the Laja River, along an 8 km strip of land from the water discharge of the Rucúe project. The project's construction time is approximately 30 months and construction is expected to be completed in September 2007. The project Feasibility Study can be found in the project file.

Quilleco's works comprise 4.4 km concrete channels, a 3.2 km aqueduct tunnel, a 105 m pressure penstock of 59.4 m height, a power house with two sets of 35 MW vertical Francis turbines and generators, a 13.8/220 kV power transformer and 300m of a 220 kV double circuit line connected to the existing 220 kV double circuit transmission line to the high voltage Charrúa substation in the Central Interconnected System (SIC). Neither Quilleco nor Rucúe, both operated by Colbún, entail any physical construction such as dams and dikes, or cause reservoir-like impoundments on the Laja River. The road from Los Angeles to Antuco is the main road in the entire area. Secondary and rural roads connect the communes of Quilleco and Tucapel. Figures A.3a, A.3b and A.4 below show the project scheme and location.

The Quilleco project will generate about 422 GWh per year under average hydrology and inject 47 MW of firm power to the SIC (Firm power is calculated by CDEC-SIC for each hydrological year, based on power availability at peaking hours of the system). The estimates are based on long-term observations of water conditions of the Laja River – see Table A.3 and Figure A.5.



Figure A.3a: Schematic map of project installations

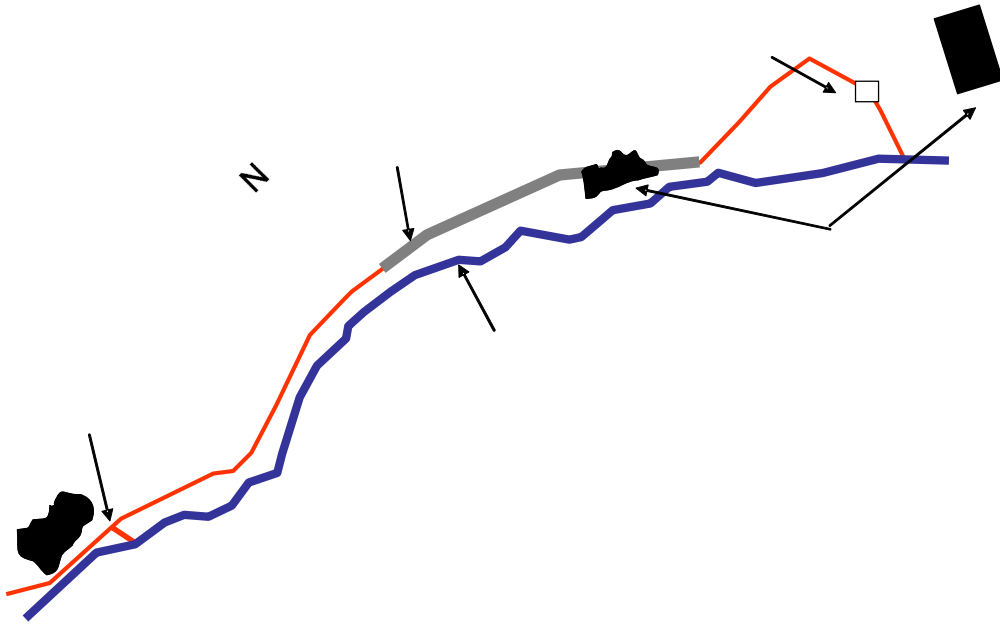


Figure A.3b Schematic drawing of project installations

# CENTRAL HIDROELECTRICA QUILLECO

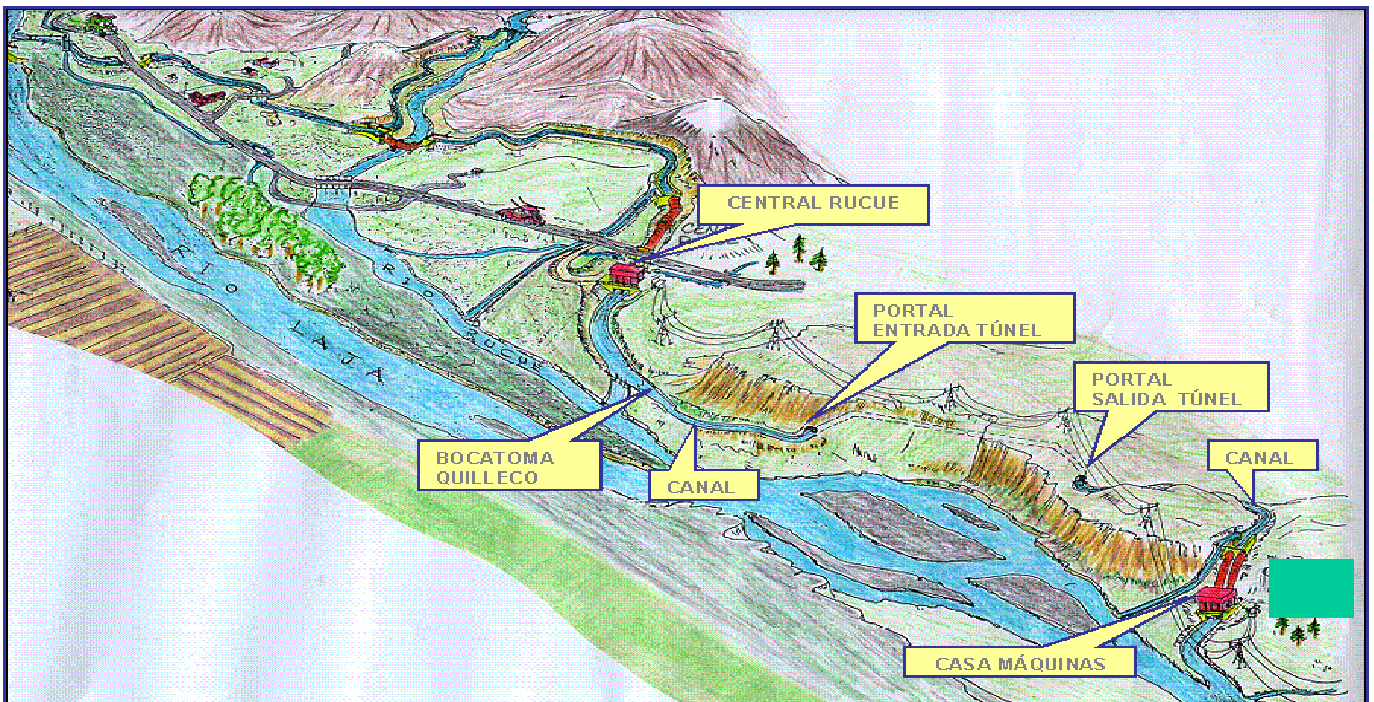
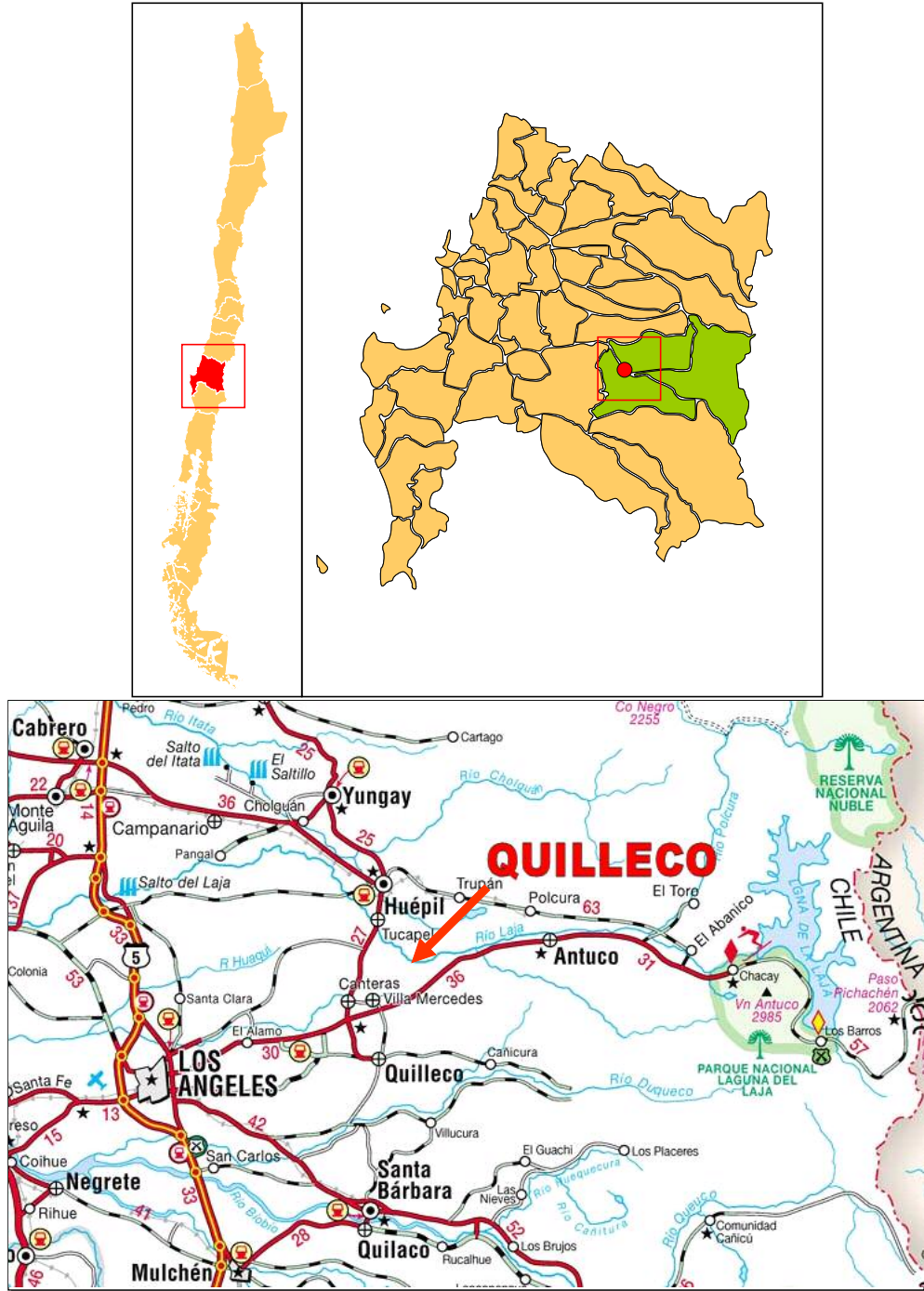


Figure A.4: Project's Location



### Satellite and Panoramic View

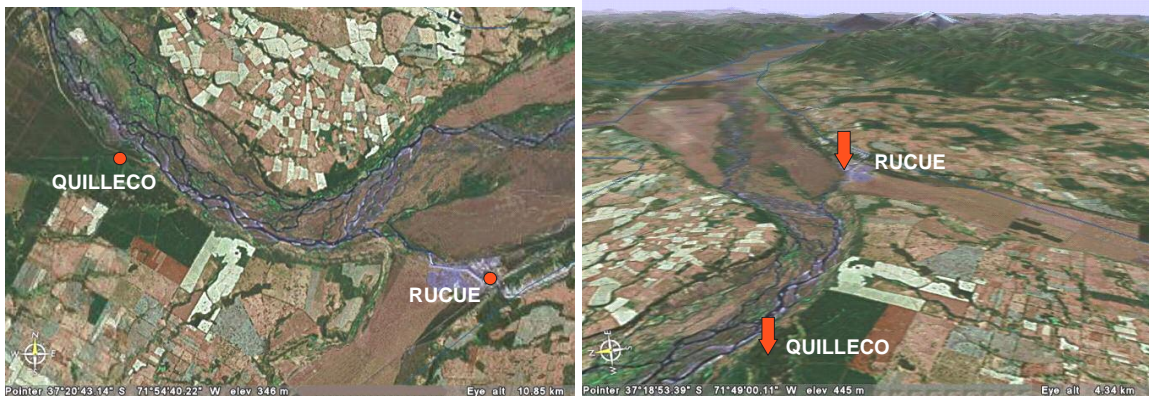
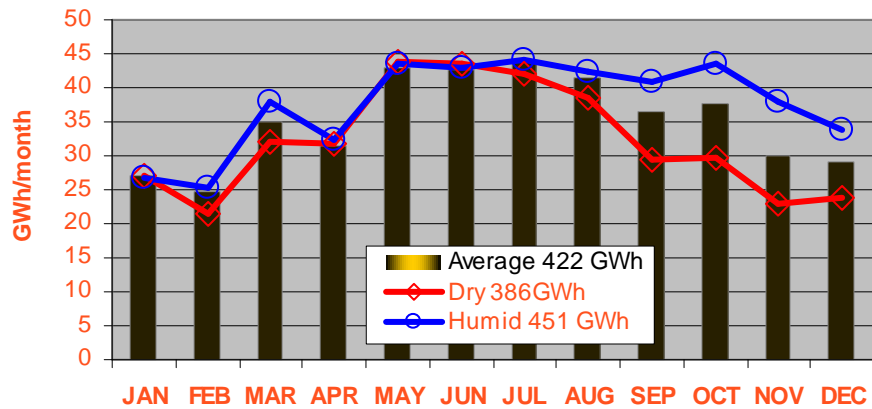


Table A.3: Quilleco Yearly Energy Production (GWh)

Hydrology	Average	Dry	Humid
JAN	27.0	26.9	26.8
FEB	24.6	21.6	25.2
MAR	35.0	32.1	38.0
APR	31.4	31.6	32.3
MAY	43.1	43.8	43.4
JUN	42.7	43.5	42.9
JUL	43.8	42.1	44.0
AUG	41.4	38.5	42.2
SEP	36.5	29.5	40.9
OCT	37.8	29,8	43.4
NOV	29.9	22.9	38.0
DEC	29.0	23.7	33.8
<b>TOTAL</b>	<b>421.9</b>	<b>386.2</b>	<b>450.9</b>

Figure A.5: Quilleco Monthly Generation



Source: Colbún estimate based on hydrology data for 40 years (1961 to 2001)

## 5. Project costs

Table A.4 summarizes project costs.

**Table A.4: Project Costs**

Description	US\$ million
<b>Power Plant</b>	<b>58.204</b>
Water intakes works	750
Aqueducts	12.573
Tunnels	16.028
Water chamber and minor intakes works	5284
Penstock	1.502
Power house	4.545
Access road and utilities	3.296
Generation equipment	14.226
<b>Transmission System:</b>	<b>2.416</b>
<b>Engineering and Administration:</b>	<b>13.162</b>
<b>Total Base Cost</b>	<b>73.782</b>
<b>Contingencies</b>	<b>5.820</b>
<b>TOTAL PROJECT COST</b>	<b>79.602</b>

Source: Colbún S.A.

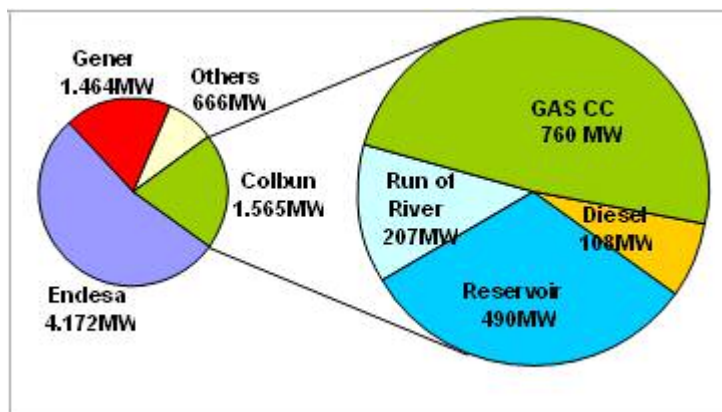
## 6. Implementation arrangements

### Project implementation

The project is being implemented by Colbún S.A., which is a private power company controlled by Grupo Matte and the Tractebel consortium. Colbún S.A. will operate the Quilleco power plant. The Grupo Matte is a Chilean holding company mainly involved in generation and retail of energy, sea port services, forestry, the pulp and paper industry, and real estate investment and development.

Colbún S.A. is the second-largest generating company in the SIC, with four hydroelectric power plants with 697 MW and 4 thermal plants with 1,118 MW of installed capacity (see table and graph below). The company produces, transports, distributes and supplies electricity and natural gas. The company also provides consulting services in the engineering field, both in Chile and abroad.

Plant Name	Type	MW
Colbún	Reservoir	400
Machicura	Reservoir	90
San Ignacio	Run of River	37
Rucúe	Run of River	170
Nehuenco	CC N. Gas	370
Nehuenco 9B	N. Gas Diesel	108
Nehuenco II	CC N. Gas	390
<b>TOTAL</b>		<b>1,565</b>



Colbún S.A. has been involved in development, ownership and operation of large storage hydroelectric plants and run-of-river plants since 1986, including another plant (Rucúe) in the Laja River basin. Colbún S.A. has a lean and efficient organization of 273 employees, and subcontracts competitively services and works. Colbún S.A. is a well-managed company with demonstrated substantial experience in construction and operation of large hydroelectric plants, including the Rucúe run-of-river plant of similar design to the proposed Quilleco project. Colbún’s environmental management system is certified according to ISO 14001.

The project is sponsored by Hidroeléctrica Guardia Vieja S.A., a subsidiary of Grupo Matte who owns other hydropower plants in Chile, including the Chacabuquito 26 MW run-of-river plant that has an ERPA agreement since 2002 with the PCF, as well as the Hornitos 55 MW run-of-river plant that is under construction.

### Monitoring and evaluation of outcomes/results

Project performance will be monitored as per a Monitoring Plan annexed to the ERPA and evaluated on the basis of generating the expected amount of ERs and subsequent issuance of CERs by the international validator. Monitoring the generation of ERs is implicit in the project as a function of actual electricity generation.

Other indicators include the satisfactory construction and operation of the project, and the satisfactory implementation of the Environmental Management Plan.

*ER Validator.* A fully independent, internationally-recognized third party (the Validator) has been recruited to provide: (a) Validation of the Baseline Methodology; and (b) Validation of the project design, additionality, and Monitoring Plan. The Validator will present a Project Design Document (PDD) for the Quilleco project along with an evaluation of the methodology chosen to measure the project CERs and to demonstrate project additionality, to the Executive Board of the CDM for approval and registry under international rules. A separate independent entity will be retained to perform the Verification and Certification of the CERs after one year of operation of the plant, and will produce a Verification Report covering (i) the amount of verified and certified ERs generated by the project; (ii) compliance with World Bank Safeguard Policies; and (iii) compliance requirements of the UNFCCC or Kyoto Protocol.

The above described approach ensures the creation of an environmental commodity that is recognized under the existing environment legislation of Chile and that will conform to relevant international agreements. It is understood that these international guidelines may change, according to decisions of the Conference of the Parties to the UNFCCC and Kyoto Protocol.

### **Sustainability**

The project is expected to be sustainable for the following main reasons: mature and liberalized power sector; excellent track record and financial position of the project implementation company; independent verification of ERs estimates.

- a) The power sector in Chile is mature and liberalized, with efficient regulatory agencies. The Chilean power sector was reformed as early as in 1982. It introduced privatization and unbundling of generation, transmission and distribution activities. Since then, the sector has been performing well, with a well-functioning power market, even though regulatory adjustments had to be made in 2004/05. Overall, the sector and regulatory risks are minimal.
- b) The project will be implemented by a private entity (Colbún S.A.) experienced in construction and operation of similar run-of-river plants on the same river (Laja). Colbún S.A. has a strong and experienced management team with a successful track record. Colbún's existing hydro-power plants are modern, well maintained and operated efficiently, according to the highest technical standards. Colbún's financial management has been prudent and profitable, as evidenced by its balance sheet and consistent profit record. Financial analysis of the project confirmed its financial viability (see Section 9).
- c) Emission reductions were estimated based on a methodology approved by the CDM Board and will be verified by an independent Validator.

The project will contribute to diversified and sustainable energy development in Chile.

### **Critical risks and possible controversial aspects**

Overall the project is rated as low risk and no controversial aspects are foreseen, as the project will not affect local population or water use. A summary of the risk assessment is presented in Table A.5.

**Table A.5: Risks Matrix**

<b>Risks</b>	<b>Risk Mitigation Measures</b>	<b>Risk Rating with Mitigation</b>
<b>Baseline risk:</b> country energy mix does not evolve as projected in baseline study, resulting in lower than expected ERs.	The project baseline, emission reductions and monitoring methodology is based on ACM002 using data from actual system operation. ERs estimates are conservative. Regarding future power generation mix, the existing uncertainties in gas supply from Argentina limit the risk of early decommissioning of coal power plants.	M
<b>Technical risk:</b> project cost overruns or construction delays (as the project entails a tunnel of 3.2 km) - resulting in postponed CER payments and lower financial rate of return for the project.	Run-of-river technology is conventional and widely used over the world and in Chile in particular. Colbún S.A. experience in the nearby Rucúe project shows execution under schedule and as per estimated budget.	M
<b>Performance and operational risk:</b> inadequate O&M or operational problems that would result in lower energy generation.	Colbún S.A. has extensive track record in developing and operating similar hydroelectric plants. It has ample knowledge of local conditions and sector regulations. Its personnel are knowledgeable and its financial position is strong. Rucúe's operation has been without problem since its commissioning. Project sales assume 70% of generated energy to be sold at node price and 30% to be sold at spot market price. This represents a reasonable contract mix for this type of project, where energy generation varies depending on hydrology.	N
<b>Off-taker risk:</b> project cannot sell its energy or project has to sell more energy than expected in a fluctuating spot market	Expected future electricity demand is enough to absorb production from new hydro and thermal projects, as included in the indicative expansion plan. Hydropower plants (in particular run-of-river plants) have priority in the merit order dispatch and therefore will displace thermal generation. Colbún S.A. already has well-defined off-takers for 60% of generation at node price and both the node price and spot market prices are expected to show a tendency to increase due to uncertainties in gas supply.	N
<b>Financial risk:</b> Financial position of Colbún worsens or project revenues are less than expected.	Colbún S.A. financial management has been prudent and profitable. The financial analysis of the project shows an acceptable rate of return with low sensitivity to key variables (hydrology, energy prices, ER revenues and investment costs).	N
<b>Country risk:</b> asset or income expropriation.	Chile is the most stable economy in LAC. Private investments operate under a very clear legal framework,	N



	with a long track record of legal security	
<b>Regulatory risk:</b> change in regulations affecting project dispatch or sales.	Chile has very clear and stable market rules and the sector regulatory environment is well established and has been very stable since the 1980s.	N
<b>Hydrological risk:</b> lower hydrology than expected, with impact on project financial viability.	Energy production has been calculated for different hydrological conditions, based on recorded measurements over 40 years. Hydrology would not affect CERs payments, because in case of low hydrology, the project's lower electricity generation would be compensated by increased substitution of carbon-intensive plants.	N
<b>Social risk:</b> public opposition to project	There are no controversial aspects foreseen in this project, which will have little impact on local populations or water use.	N
<b>Overall risk rating</b>		<b>L</b>

## 7. Financial management and disbursement arrangements

The project does not include World Bank Group financing, but the World Bank acts as Trustee of the NCDMF for payment of CERs under the ERPA.

**Payment for CERs and Flow of Funds:** The schedule of payments is based on the delivery of CERs as established in the ERPA (see estimated payments in Table A.6). HGV shall make requests for payment to the NCDMF under the ERPA. The NCDMF will only pay HGV upon transfer of CERs. In the event that Quilleco fails to deliver the quantity of CERs for any given calendar year as set forth in the ERPA, the project will be required to make-up the shortfall over the course of the following calendar year or in another period as agreed with NCDMF. The involvement of the NCDMF will expire after the total CERs contracted amount of tCO<sub>2</sub>e has been delivered.

**Table A.6: Estimated payments by NCDMF for Certified Emission Reductions**

	2006	2007	2008	2009	2010	2011
Net Generation (GWh)		106	422	422	422	422
Total ER (tCO <sub>2</sub> e x 10 <sup>3</sup> )		50	200	200	200	200
NCDMF Purchase (tCO <sub>2</sub> e x 10 <sup>3</sup> )		0	100	100	100	100
NCDMF Payment (US\$ million)		0	0.75	0.75	0.75	0.75

## 8. Procurement

The works and services for Quilleco project have been procured by Colbún following its own procurement rules since there is no Bank financing. All works have been contracted with reputable firms which are currently executing 5 contracts for the construction of canals, tunnel, and powerhouse, and the supply and erection of penstocks and electromechanical equipment.



## 9. Economic and financial analysis

### Economic evaluation

#### *Project additionality*

The Kyoto Protocol requires that “reductions in emissions are additional to any that would occur in the absence of the certified project activity.” This “environmental additionality” of the project is assessed against a baseline, which describes what would happen without the proposed project. Consequently, carbon finance requires that supported projects demonstrate environmental additionality. A project is additional if the scenario “with the project” generates fewer greenhouse gas emissions than the baseline (“business as usual”) scenario.

In a centrally planned system, the baseline scenario can be determined on the basis of the least-cost expansion as defined by a planning authority. In Chile, however, there is no central planning for expansion of power facilities. Generation is privately-owned and competitive. All current and prospective generators make their own judgments and take their own risks on amount of capacity to be installed, based on their perception of demand growth, the expected evolution of capital and fuel markets, and any other parameters that may influence their businesses. Therefore, the baseline can be determined only as the most likely scenario of capacity additions private investors would choose on the basis of demand and price projections, investment costs and expected price of fuels. In the Chilean case, the most likely scenario is the indicative generation expansion plan prepared by the CNE based on information provided by the power generating companies. The appropriate method to determine the environmental additionality in the context of the Chilean power sector is to compare the proposed project with this indicative likely scenario of least-cost generation capacity additions.

Three alternatives of thermal generation expansion were identified that could be compared to the Hornitos project: (i) coal-fired steam plants; (ii) gas-fueled combined-cycle (CC) plants; and (iii) gas-fueled open cycle plants. Generation costs for these alternatives, at the time when the sponsor made its investment decision, are shown in Table A.7. The baseline study has determined that gas fueled CC plants represent the least-cost option for all discount rates between 10 and 16 % p.a. The results of this analysis are consistent with the CNE’s indicative expansion plan, that does not include the Quilleco project (See Table A.8).

**Table A.7: Generation Costs of Thermal Options (US\$/MWh)**

Thermal Option	Plant Factor	Unit Investment cost	Generation Cost (1)
		US\$/MW	US\$/MWh
Combined Cycle (NG) (2)	0.85	500	23.2
Open Cycle (NG) (2)	0.85	450	38.2
Coal	0.8	800	44.6
Diesel	0.8	300	127.1

(1) At 10% discount rate.

(2) With gas prices as per existing contracts, i.e. about US\$2.8/MMBtu at plant gate

**Table A.8: CNE's Indicative Expansion Plan for the SIC**

Month	Year	Project	Capacity (MW)
April	2006	Coya Pangal Hydro Power Plant (Run of River)	25
October	2007	V Region Hydro Power Plant (Run of River)	65
October	2007	Combined Cycle Natural Gas Plant # 1 (VIII Region)	385
January	2008	La Higuera Hydro Power Plant (Run of River)	155
April	2008	Combined Cycle Natural Gas Plant # 2 (VIII Region)	385
April	2009	Calabozo Geothermal Plant Stage 1	100
April	2009	Combined Cycle Natural Gas Plant # 3 (VIII Region)	381
January	2010	Confluencia Hydro Power Plant (Run of River)	155
April	2010	Calabozo Geothermal Plant Stage 2	100
January	2011	Combined Cycle Natural Gas Plant # 4 (VIII Region)	381
April	2011	Neltume Hydro Power Plant (Reservoir)	400
April	2011	Calabozo Geothermal Plant Stage 3	100
January	2013	Combined Cycle Natural Gas Plant # 5 (VIII Region)	379
October	2013	Combined Cycle Natural Gas Plant # 6 (VIII Region)	379

Source: CNE Capacity expansion program, Node Price, Technical Report April 2004

In Table A.9, Quilleco generation costs are compared to those of the least-cost thermal alternative, i.e. the natural gas CC plant. The comparison shows that, at the time when the Colbun made its investment decision, Quilleco generation cost was greater than the cost of the natural gas CC plant.. Likewise it was been verified that given the small size of the Quilleco project compared with the total installed capacity of the SIC (about 7.867 MW in December 2004) and the requirements of new plants for the period 2007-2017, the project would not alter the least-cost expansion plan and can be considered as a marginal displacement plant.

**Table A.9: Quilleco Generation Cost**

Discount Rate	Capital Cost (1)	Operating Costs	Total Annual Cost	Quilleco Project	Natural Gas CC alternative
	000' US\$/ year	000' US\$/ year	000'US\$/ year	000'US\$/MWh	000'US\$/MWh
10%	8,444	1,000	9,444	24.9	23.2
12%	9,882	1,000	10,882	25.8	24.3
14%	11,367	1,000	12,367	29.3	25.5

(1) Quilleco's project economic life is assumed to be 40 years; capital costs do not include financing costs.

The case for the environmental additionality is further established in the financial analysis, which demonstrates the impact of carbon revenues on the internal rate of return (IRR). The financial analysis shows that carbon revenues can increase the IRR of the Quilleco project to a level attractive for the private sector, with an improvement of the IRR by 1.5% from a marginally attractive 10%. (Detailed analysis is included in the Financial Evaluation section below).

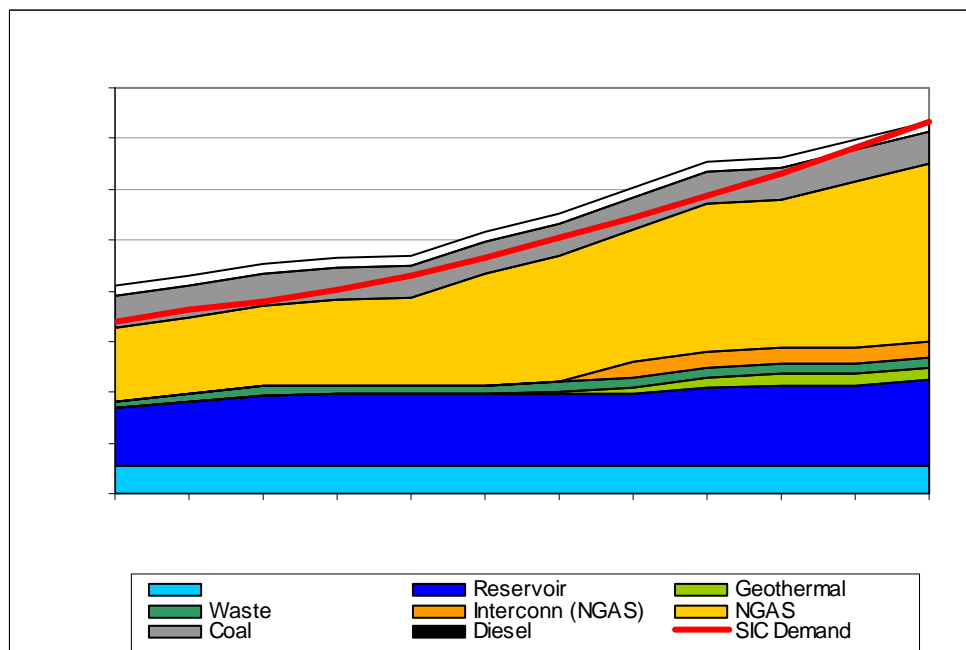
Although project construction started in December 2004, the PIN was presented by the sponsor to the WB's Carbon Finance Unit before that date, which is evidence that the sponsor had taken into account the requested carbon financing before deciding to invest in the project.

## Baseline methodology and ERs

Average net generation of about 422 GWh per year will translate into approximately 200,000 tCO<sub>2</sub>e avoided to the atmosphere, corresponding to a mix of coal and gas-based generation to be displaced by the Quilleco project. The project ERs have been estimated based on the Consolidated Methodology ACM002 approved by the CDM Executive Board, with the operating margin (OM) emission factor calculated on the basis of actual dispatch analysis – using a long term dispatch model of the Chilean SIC that the regulatory authority actually uses for node price estimates. With this model, it is possible to forecast the thermal plants displaced by the Quilleco project, using actual dispatch data for the SIC as recorded by the Economic Load Dispatch Center (CDEC). The Build Margin (BM) emission factor is calculated on the basis of most recently built power plants in the SIC. The baseline emission factor is the weighed average of the OM and BM emission factors and has been estimated at 475 tCO<sub>2</sub>/GWh.

It should be noted that the Chilean dispatch seeks to optimize system's operation - generation units being dispatched in merit order of increasing marginal costs (the principles of sector operation are set in the General Electricity Law and Regulations). This process ensures that run-of-river hydropower plants (such as Quilleco) with lowest marginal costs will always be dispatched. The last plants in line for dispatch will be first the least efficient diesel or coal-fired plants and then natural gas based power plants.

Figure A.6



displaced by hydro and natural gas Combined Cycle plants. The baseline scenario, however, is considered as the most likely in the foreseeable future (next decade).

Dry hydrological conditions are not expected to have a very significant influence on ER delivery. First, dry and wet periods are likely to be relatively balanced over a long period of time. Second, the variation in energy production between wet and dry years is within reasonable limits. Third, lower energy production in dry years would be partly compensated by higher ER, as less efficient, more carbon intensive thermal plants would have to be dispatched to compensate for the lower hydro generation.

It should also be noted that the intended interconnection between the northern and the central systems (SING and SIC) should not affect the project assumptions regarding Quilleco' displacement of thermal generation, as the northern system is almost exclusively based on thermal generation, mainly natural gas and coal-fired thermal plants.

### **Financial evaluation**

*Project costs and financing.* The project will cost approximately US\$79.6 million including contingencies and VAT but excluding financing charges. This cost of about US\$1,140/kW is considered reasonable for a run-of-river plant of this size and characteristics.

The project will be financed by Colbún S.A. through equity inflow. After commissioning of the project, Colbún S.A. will seek the best financing structure according to its interest.

*Project production.* Expected monthly energy production is shown in Figure A.5, for average and dry hydrology scenarios. In winter time, the project generation is reduced, since most of the precipitations in the upper part of the basin remain in the mountains as snow. In summer time, snow melting increases the river flows and the project generation, allowing the project to sell surplus energy in the spot market.

The share of contracted energy (70%), sold at a higher price in average years compared to the spot market, has been chosen by Colbún S.A. to minimize the risk of having to buy energy in the winter to meet its contract, at high spot prices during dry years.

*Project cash flow.* Based on assumptions summarized in Box A.2, the projected financial cash flow for the Quilleco project under average hydrology is summarized in Table A.10 (values shown only until 2012, though the financial analysis is made over a 30 year period), including: (a) revenues from sales of energy, capacity payments and CERs sales (estimated with ACM002 over a 21 year period); (b) investment; (c) operation, maintenance and administrative expenses; and (d) estimates of accelerated depreciation based on Chilean income tax law (the project will not be levied with tax during the first six years of operation in the scenario with no ERs income, as this scenario would yield negative operating revenues). Colbún S.A. expects to contract out 287 GWh/year at an estimated node price of 29 US\$/MWh, and 123 GWh at an estimated spot price of 18 US\$/MWh, and receive capacity payments of 62.5 US\$/kW-year. These node prices estimates are consistent with both official and market forecasts. The spot price used for the financial projections is higher than 14.8 US\$/MWh, which has been the historical average during

summer, when the project generates surplus energy and the system presents higher hydropower generation, and combined cycle natural gas and efficient coal fired plants are operating at the margin. This is a conservative estimate, as spot prices are expected to increase in the future due to uncertainties in gas supply.

*ER revenues.* The project is expected to substitute at the margin a mix of coal and natural gas-based electricity, with an average emission factor of 475 tCO<sub>2</sub>/GWh, which would result in ERs close to 4.2 million of tCO<sub>2</sub>e for 21 years, and ER revenues of about US\$31.5 million over the same period.

#### Box A.2: Assumptions for Quilleco financial analysis

- Node Price: CNE node price reported in April, 2004 (Energy price: 28.9 US\$/MWh; and Capacity price: 62.5 US\$/MWyear, at Charrúa substation)
- Spot Price: 18 US\$/MWh
- Contract Energy: 70% at node price and 30% sold in the Spot Market
- Net energy generation obtained by hydrological model with annual average of 422 GWh
- Firm capacity sales of 47 MW per year (project firm capacity adjusted for overall demand in SIC)
- System expansion based on last CNE report, April 2004
- System operation estimated with OSE 2000 electric model used by CNE to calculate node prices
- CO<sub>2</sub> displacement based on ACM002
- Project startup in September 2007
- Sale of 100% of emission reductions

**Table A.10: Financial Projection of Quilleco Project - Cash Flow (Thousand US\$)**

Without ER Sales	2005	2006	2007	2008	2009	2010	2011	2012
Energy GWh		-	106	422	422	422	422	422
Firm Power MW		-	-	35	47	47	47	47
<b>INVESTMENT</b>	<b>-39.800</b>	<b>-39.800</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>INCOME</b>	<b>-</b>	<b>-</b>	<b>2.161</b>	<b>12.711</b>	<b>13.446</b>	<b>13.446</b>	<b>13.446</b>	<b>13.446</b>
SPOT ENERGY	-	-	1.469	2.210	2.210	2.210	2.210	2.210
CONTRACT ENERGY	-	-	691	8.297	8.297	8.297	8.297	8.297
CAPACITY	-	-	-	2.204	2.939	2.939	2.939	2.939
ER INCOME	-	-	-	-	-	-	-	-
<b>COST</b>	<b>-</b>	<b>-</b>	<b>-950</b>	<b>-2.800</b>	<b>-2.800</b>	<b>-2.800</b>	<b>-2.800</b>	<b>-2.800</b>
O&M	-	-	-500	-1.000	-1.000	-1.000	-1.000	-1.000
TOLL	-	-	-450	-1.800	-1.800	-1.800	-1.800	-1.800
<b>EBDIT</b>	<b>-</b>	<b>-</b>	<b>1.211</b>	<b>9.911</b>	<b>10.646</b>	<b>10.646</b>	<b>10.646</b>	<b>10.646</b>
<b>DEPRECIATION</b>	<b>-</b>	<b>-</b>	<b>-633</b>	<b>-7.599</b>	<b>-7.599</b>	<b>-7.599</b>	<b>-7.599</b>	<b>-7.599</b>
<b>OPERATIONAL REVENUE</b>	<b>-</b>	<b>-</b>	<b>577</b>	<b>2.312</b>	<b>3.047</b>	<b>3.047</b>	<b>3.047</b>	<b>3.047</b>
<b>CASH FLOW</b>	<b>-39.800</b>	<b>-39.800</b>	<b>1.211</b>	<b>9.911</b>	<b>10.646</b>	<b>10.646</b>	<b>10.646</b>	<b>10.646</b>

<b>With ER sales</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>
Energy GWh		-	106	422	422	422	422	422
Firm Power MW		-	-	35	47	47	47	47
<b>INVESTMENT</b>	<b>-39.800</b>	<b>-39.800</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>INCOME</b>	<b>-</b>	<b>-</b>	<b>2.549</b>	<b>14.265</b>	<b>15.000</b>	<b>15.000</b>	<b>15.000</b>	<b>15.000</b>
SPOT ENERGY	-	-	1.469	2.210	2.210	2.210	2.210	2.210
CONTRACT ENERGY	-	-	691	8.297	8.297	8.297	8.297	8.297
CAPACITY	-	-	-	2.204	2.939	2.939	2.939	2.939
ER INCOME	-	-	388	1.554	1.554	1.554	1.554	1.554
<b>COST</b>	<b>-</b>	<b>-</b>	<b>-950</b>	<b>-2.800</b>	<b>-2.800</b>	<b>-2.800</b>	<b>-2.800</b>	<b>-2.800</b>
O&M	-	-	-500	-1.000	-1.000	-1.000	-1.000	-1.000
TOLL	-	-	-450	-1.800	-1.800	-1.800	-1.800	-1.800
<b>EBDIT</b>	<b>-</b>	<b>-</b>	<b>1.599</b>	<b>11.465</b>	<b>12.200</b>	<b>12.200</b>	<b>12.200</b>	<b>12.200</b>
<b>DEPRECIATION</b>	<b>-</b>	<b>-</b>	<b>-633</b>	<b>-7.599</b>	<b>-7.599</b>	<b>-7.599</b>	<b>-7.599</b>	<b>-7.599</b>
<b>OPERATIONAL REVENUE</b>	<b>-</b>	<b>-</b>	<b>966</b>	<b>3.866</b>	<b>4.601</b>	<b>4.601</b>	<b>4.601</b>	<b>4.601</b>
<b>CASH FLOW</b>	<b>-39.800</b>	<b>-39.800</b>	<b>1.599</b>	<b>11.465</b>	<b>12.200</b>	<b>12.200</b>	<b>12.200</b>	<b>12.200</b>

The previous table presents a cash flow for a normal hydrology scenario. The ER abatement has been calculated using ACM002, that uses an average emission factor of all thermal units been dispatched in the system. Based on historical data of the past 3 years, the operating margin OM has an average of 550tCO<sub>2</sub>e/GWh. The build margin BM has been estimated as 400 tCO<sub>2</sub>e/GWh from CNE 10 year forecast for capacity development. Under this scenario the project is expected to abate at an average of 475tCO<sub>2</sub>/GWh), which would result in a total ER purchase of 1,052,000 tCO<sub>2</sub>e and an income of US\$ 7.9 million over the period 2007- 2012 (considering 6 EUR/tCO<sub>2</sub>e or 7.5 US\$/tCO<sub>2</sub>e). The above table assumes carbon revenues during 21 years of operation, i.e. 3 crediting periods.

*Rate of return.* The internal rate of return on assets (IRROA) of Quilleco without sale of ER is 10.28 %. It increases to 11.52% with the sale of ER. Net present value (NPV) without the sale of ER is US\$ 2.4 million at 10% discount rate (the Chilean power sector discount rate used by the authority to calculate expansion system cost for determining node prices). It increases to US\$ 11.7 million when ER revenues are added. (See Table A.11).

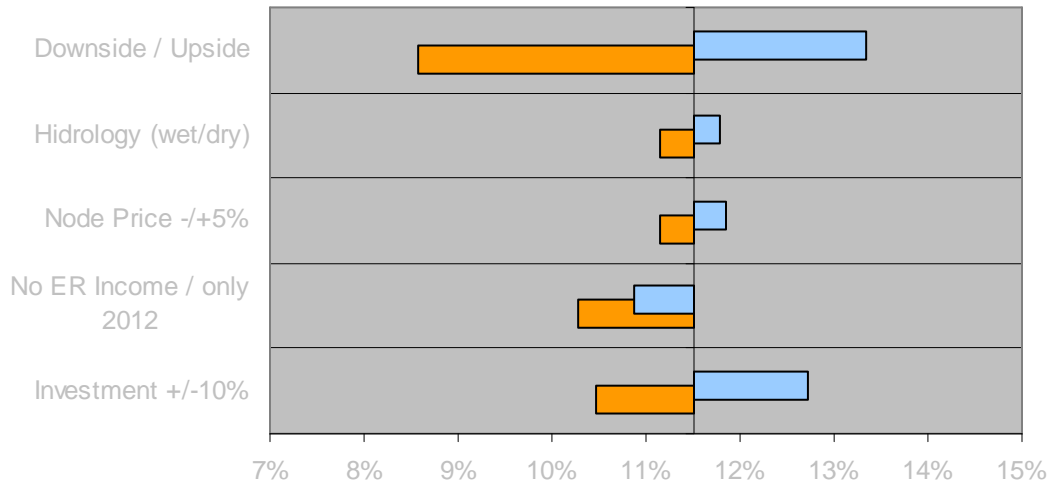
Although the project's rate of return might seem to be on the low side, Colbún's decision to invest in this project can be explained for a variety of reasons: (i) additional revenues generated by ERs, that were estimated conservatively; (ii) Colbún's overall strategy to increase its hydropower generation assets with low hydrology risk, to improve its generation portfolio diversification; (iii) project risks are low; (iv) project assets will continue to generate energy much beyond the project financial evaluation period; (v) some project costs are shared to some extent with Colbún's other plants in the same area; and (vi) the project rate of return is within the range of rates of return for power generation projects of this type in Chile.

**Table A.11: Quilleco Project: Financial Analysis – Base Case**

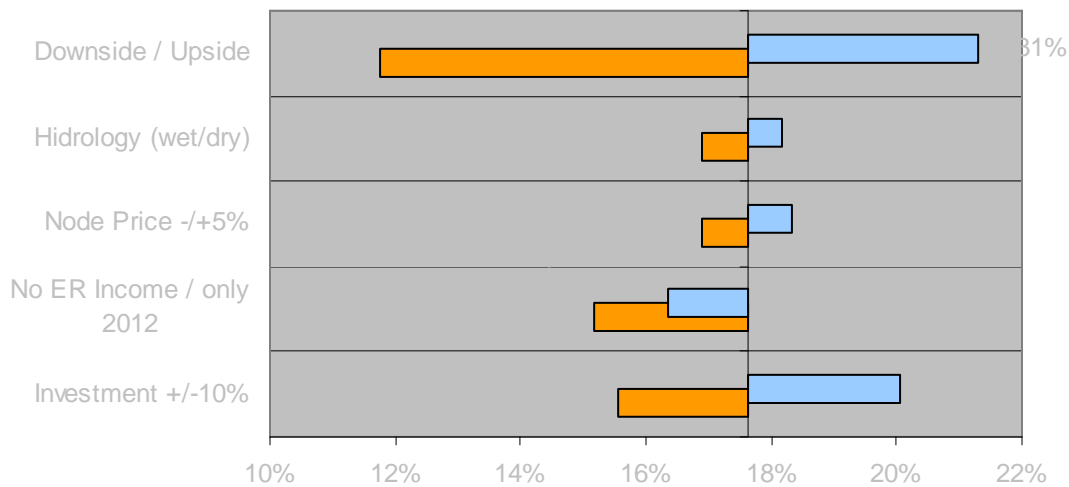
	<b>Without ER income</b>	<b>With ER income</b>
IRROA	10.28%	11.51%
IRROE (50% debt)	15.17%	17.62%
NPV at 10 % (US\$ mill)	2.4	11.7

A sensitivity analysis has been carried out to assess impact on IRR and NPV of changes in hydrology, energy prices, ER sales and investment costs. The sensitivity to reasonable variations in these variables was found to be low (see Figures A.7a and A.7b). Downside and upside scenarios are shown as the sum of all negative effects (bars in black) and all positive effects (bars in grey) – giving a range of 8.6% - 13.45 for the IRR on assets.

**Figure A.7a: Sensitivity of internal rate of return on assets**



**Figure A.7b: Sensitivity of internal rate of return on equity (50% equity)**



## Colbún's Past Financial Performance and Present Condition

Historically, Colbún has held a prudent financial and investment policy and has consistently shown a profitable financial performance, as shown in its financial statements for the last three years. Net income was US\$166.5 million in 2003 and US\$146.8 million in 2004, resulting in a ratio of net income to total assets of 10% and 8%, respectively (see Table A.12).

Operational results and earnings before depreciation, interest and taxes were stable during the period 2003 to 2004, largely thanks to stable contractual relations of Colbún S.A with its main clients: Chilectra, Codelco, Conafe, Saesa and CMPC. Accounts receivable also maintain an excellent standard (see Table A.13). Financial statements of 2005 have not been approved yet by Colbún's Board but they confirm Colbún's strong financial performance.

Balance sheet as of December 2004 shows total assets amounting to US\$1,853 million while total equity is US\$1,250 million or 67.5% of total assets. There are no significant guarantees on subsidiaries affecting assets of Colbún S.A. This solid capitalization is part of the tradition of the Matte family, principal owners of the holding company, who strongly believe in maintaining a sound equity position and minimizing debt (see Table A.14).

**Table A.12 Consolidated Results of Colbún for 2002, 2003 and 2004**

COLBÚN INCOME STATEMENT	2002	2003	2004
	In thousand of US\$		
<b>OPERATING INCOME</b>	<b>87,065</b>	<b>132,948</b>	<b>118,350</b>
<b>GROSS PROFIT</b>	<b>93,243</b>	<b>146,650</b>	<b>146,955</b>
NET REVENUE	206,585	338,279	406,395
COST OF SALES	(113,342)	(191,627)	(259,440)
ADMINISTRATIVE AND SELLING EXPENSES	(6,179)	(13,703)	(28,607)
<b>NON-OPERATING INCOME</b>	<b>(20,037)</b>	<b>33,561</b>	<b>28,492</b>
Financial income	9,608	2,138	1,014
Equity in income of related companies	1,103	15,761	14,944
Other non-operating income	2,757	3,205	20,867
Equity in loss of related companies	0	(531)	(939)
Amortization of goodwill	0	0	0
Financial expenses	(24,854)	(30,565)	(27,648)
Other non-operating expense	(3,044)	(13,634)	(7,034)
Price-level restatement	4,513	247	54
Exchange differences	(10,123)	56,943	27,233
<b>INCOME BEFORE INCOME TAXES</b>	<b>67,026</b>	<b>166,511</b>	<b>146,842</b>
INCOME TAXES	(2,028)	(6,109)	(8,312)
<b>NET INCOME FOR THE YEAR</b>	<b>65,000</b>	<b>160,402</b>	<b>138,528</b>

Source: Colbún S.A. Annual Reports for 2002, 2003 and 2004



**Table A.13 Consolidated Balance Sheet of Colbún for 2002, 2003 and 2004**

COLBUN BALANCE SHEET STATEMENT	2002	2003	2004
	In thousand of US\$		
<b>ASSETS</b>			
<b>Total Current Assets</b>	<b>109,597</b>	<b>141,032</b>	<b>161,932</b>
Cash	22	17	101
Time deposits	38,903	19,592	14,104
Marketable securities – net	26,843	44,519	10,465
Trade accounts receivable – net	18,557	24,296	70,648
Other receivable – net	1,283	1,556	3,440
Due from related companies	2,299	31,370	20,176
Inventories – net	226	171	205
Recoverable taxes	6,604	447	5,937
Prepaid expenses	2,343	2,234	2,406
Deferred taxes	91	123	136
Others	12,425	16,708	34,314
	<b>0</b>	<b>0</b>	<b>0</b>
<b>Total Property, Plant and Equipment</b>	<b>1,186,468</b>	<b>1,518,472</b>	<b>1,643,115</b>
Land	26,939	32,655	34,883
Buildings and infrastructure	982,542	1,244,728	1,341,399
Machinery and Equipment	476,462	698,044	897,865
Other property, plant and equipment	154,257	150,024	71,779
Technical revaluation of property, plant and equipment	15,654	19,550	20,883
Less: accumulated depreciation	(469,386)	(626,528)	(723,695)
<b>Total Other Assets</b>	<b>31,259</b>	<b>43,324</b>	<b>48,016</b>
Investments in related companies	11,868	18,913	17,968
Investment in other companies	77	97	126
Other long-term receivable	768	254	163
Due from related companies- long-term	1,690	1,024	546
Intangibles	2,637	5,208	5,564
Amortization	(259)	(482)	(686)
Others	14,479	18,311	24,336
<b>TOTAL ASSETS</b>	<b>1,327,324</b>	<b>1,702,829</b>	<b>1,853,063</b>
<b>LIABILITIES AND SHAREHOLDERS' EQUITY</b>			
<b>Total Current Liabilities</b>	<b>77,432</b>	<b>159,936</b>	<b>185,167</b>
Short-term liabilities with banks and financial institution	0	0	62,749
Long-term liabilities with banks and financial institution	3,681	2,538	1,603
Bonds – current maturities	14,906	28,903	44,670

COLBUN BALANCE SHEET STATEMENT	2002	2003	2004
	In thousand of US\$		
Long-term liabilities – current maturities	1,997	44	2,079
Dividends payable	10,843	16,815	8,910
Accounts payable	5,259	3,339	11,492
Notes payable	25,321	75,862	7,232
Other payable	98	32	39
Due to related companies	390	871	1,052
Accruals	10,948	16,849	28,580
Withholdings	2,971	5,790	11,729
Unearned income	462	538	492
Others	554	8,356	4,540
<b>Total Long-Term Liabilities</b>	<b>491,483</b>	<b>462,600</b>	<b>417,966</b>
Liabilities with banks and financial institutions	220,241	225,045	220,158
Bonds payable	143,952	153,682	121,706
Notes payable	114,274	41,694	33,991
Others payable	0	3,069	3,002
Accruals	430	620	815
Deferred taxes	5,611	17,521	27,023
Others	6,974	20,968	11,271
<b>Total Shareholders' equity-net</b>	<b>758,985</b>	<b>1,080,292</b>	<b>1,249,932</b>
Paid-in capital	570,983	713,129	761,781
Share premium	21,641	27,029	28,874
Other reserves	15,703	19,613	20,952
Retained earnings	96,444	176,745	308,512
Net income for the year	65,000	160,402	138,528
Interim dividends	(10,788)	(16,625)	(8,715)
<b>TOTAL LIABILITIES AND SHAREHOLDERS' EQUITY</b>	<b>1,327,899</b>	<b>1,702,829</b>	<b>1,853,065</b>

Source: Colbún S.A. Annual Reports for 2002, 2003 and 2004

**Table A.14 Consolidated Statements of Cash Flow of Colbún for 2002, 2003 and 2004**

COLBÚN CASH FLOW STATEMENT	2002	2003	2004
	In thousand of US\$		
<b>NET CASH PROVIDED BY OPERATING ACTIVITIES</b>	<b>118,919</b>	<b>147,007</b>	<b>123,596</b>
Cash received from customers	247,251	294,768	352,199
Interest income received	8,989	1,724	2,612
Dividends and other distributions received	4,044	8,025	5,427
Other income received	(104,790)	782	539
Payment to suppliers and employees	0	(118,387)	(179,788)
Interest paid	(21,877)	(29,348)	(22,449)
Other expenses paid	(1,972)	(9,560)	(10,007)
VAT and others paid	(12,726)	(998)	24,937
<b>NET CASH PROVIDED BY (USED IN) FINANCING ACTIVITIES</b>	<b>42,012</b>	<b>(69,192)</b>	<b>(92,673)</b>
Proceeds from issuance of capital stock	34,124	0	0
Proceeds from loans	55,571	0	71,343
Dividends paid	(4,171)	(24,163)	(51,628)
Loan payments	(39,459)	(29,445)	(84,454)
Bond payments	(4,054)	(15,583)	(27,932)
<b>NET CASH USED IN INVESTMENT ACTIVITIES</b>	<b>129,688</b>	<b>(96,010)</b>	<b>(57,844)</b>
Proceeds from sale of property, plant and equipment	281	570	991
Proceeds from sale of permanent investments	0	1,047	90
Proceeds from other loans to related companies	0	26,452	33,968
Other investment inflow	120	313	702
Payment of capitalized investment	(650)	0	0
Purchase of property, plant and equipment	(126,674)	(112,420)	(86,417)
Permanent investments	(2,767)	(178)	(111)
Other investment outflow	0	(11,793)	(7,065)
<b>TOTAL POSITIVE (NEGATIVE) CASH FLOW FOR THE YEAR</b>	<b>31,243</b>	<b>(18,195)</b>	<b>(26,921)</b>
<b>EFFECT OF INFLATION ON CASH AND CASH EQUIVALENTS</b>	<b>865</b>	<b>(2,780)</b>	<b>(1,720)</b>
<b>NET INCREASE (DECREASE) IN CASH AND CASH EQUIVALENT</b>	<b>32,109</b>	<b>(20,975)</b>	<b>(28,639)</b>
<b>CASH AND CASH EQUIVALENT AT BEGINNING OF YEAR</b>	<b>43,291</b>	<b>93,729</b>	<b>77,720</b>
<b>CASH AND CASH EQUIVALENT AT END OF YEAR</b>	<b>75,399</b>	<b>72,756</b>	<b>49,079</b>

Source: Colbún S.A. Annual Reports for 2002, 2003 and 2004

## **10. Environmental Analysis:** (Risk Level: LOW)

### **Environmental Category: B**

An EIA was completed for the Quilleco project and approved by the local environmental authority (COREMA). It was reviewed and found satisfactory by the environmental and social specialists of the Bank team.

### **Legal Compliance**

The EIA was first presented to COREMA in October 1998 and approved on December 16, 2000. In compliance with the Chilean environmental law, the EIA was distributed to 11 local authorities selected by COREMA in consideration to their legal relation to identified impacts of the project. These are:

- National Fishing Service (*Servicio Nacional de Pesca*)
- Municipality of Tucapel
- Municipality of Quilleco
- National Agriculture Service (*Servicio Agrícola y Ganadero, SAG*)
- Local Health Service (*Servicio de Salud Bío Bío*)
- National Energy Commission (*Comisión Nacional de Energía, CNE*)
- Fishing Undersecretary (*Subsecretaría de Pesca*)
- National Monument Council (*Consejo de Monumentos Nacionales*)
- General Water Directorate (*Dirección General de Aguas, DGA*)
- National Forestry Corporation (*Corporación Nacional Forestal, CONAF*)
- National Tourism Service (*Servicio Nacional de Turismo, SERNATUR*)

Comments, observations and questions received from the above mentioned authorities were answered by Colbún S.A during the EIA process. The answers were compiled in four documents added to the EIA before the final approval by COREMA. Most legal permits and authorizations required to carry out the project were obtained in 1998 and 1999.

As established by the Chilean law, the EIA included a public consultation period of 60 days. Every observation, question or comment was assessed by COREMA and answered in the final EIA resolution. Even though the EIA was approved about 5 years ago (December 16, 2000), COREMA will not make further requirements to Colbún S.A. or changes to the EIA resolution, as confirmed to the WB task team in September 2004. COREMA has monitored the environmental commitments since project construction begun and has found Colbún to be in compliance with these commitments.

Table A.15 summarizes status of all legal permits and authorizations requested by Colbún as of October 2005.

**Table A.15. Status of Legal Permits and Authorizations of Quilleco Hydroelectric Project (as of October 2005)**

Permissions, Authorization and/or Sectorial Commitments							
Description	Competent Authority	Responsibility		Observations	Status		
		Preparation	Presentation		Approval.	Started	No Progress
COLBÚN							
EIA	CONAMA Region.	VIII	Colbún	Colbún	Approved via resolution	X	
Land Use Change	Min. of Agriculture		Colbún	Colbún	Sites Dos A; Dos B; Dos C; Dos D Roles 509-89; 509-90; 509-91; 509-92 ORD 06	X	
Fauna Rescue	CONAMA		Colbún	Colbún	Executed by biologist Mr. Jorge Mella, Diciembre 2004	X	
External Env. Audits	CONAMA		Colbún	Colbún	Executed by EULA, monthly	X	
Installation of Works	Quilleco Municipality		Colbún	Colbún	Associated to construction permission	X	
Sanitary Technical Report	Bio Bio Health Service		Colbún	Colbún	By End of project construction		X
Commercial Patent	Municipal Treasurer Quilleco		Colbún	Colbún	By End of project construction		X

Permissions, Authorization and/or Sectorial Commitments							
Description	Competent Authority	Responsibility		Observations	Status		
		Preparation	Presentation		Approval.	Started	No Progress
Feasibility of particular potable water and sewer system	Min. Of Health		Colbún	Colbún	Certification 1196	X	
Working Area Potable water and sewer system approval.	Health Service Bio Bio		Colbún	Colbún	Approved	X	
Sewer System Reception Working Area	Health Service Bio Bio		Colbún	Colbún		X	
Quilleco Power Plant Potable Water and Sewer System Approval	Min. Of Health		Colbún	Colbún	By the End of Project Construction		X
Quilleco Power Plant Potable Water and Sewer System Reception	Min. of Health		Colbún	Colbún	By the End of Project Construction		X
Working Area Treatment Plant Authorization	Health Service Bio Bio		Colbún	Colbún		X	
Working Area Electric Project Inscription	SEC		Colbún	Colbún	Inscripcion N° 177244 18/03/05	X	
External Electric Project	SEC		Colbún	Colbún	By the End of Project Construction		X

Permissions, Authorization and/or Sectorial Commitments								
Description	Competent Authority	Responsibility			Observations	Status		
		Preparation	Presentation			Approval	Started	No Progress
Quilleco Hydraulic Works Approval	Water (DGA)	Authority	Colbún	Colbún	Res. Exenta DGA N° 397 Res. DGA. 301, Rectifica resolución DGA N° 397 (exenta)		X	
Quilleco Hydraulic Works Project Approval	Min. of Public Works	Public	Colbún	Colbún	Res. 397		X	
Construction Permission	Municipality of Quilleco	of	Colbún	Colbún	Ingreso N° 20064  Res. N° B-814/99 D.L. N° 701 de 1974 Res. N° 2026		X	
Forestry Plan Management	CONAF		Contractor	Colbún	Res. N° 1050/32-5/04 D.L. 701, de 1974 Res. N° 2027 Res. N° 2028 Res. N° 2024		X	

Permissions, Authorization and/or Sectorial Commitments								
Description	Competent Authority	Responsibility			Observations	Status		
		Preparation	Presentation			Approval	Started	No Progress
ZÜBLIN								
Working Area Treatment Authorization	Contractor Plant	Health Service Bio Bio	Contractor	Contractor			X	
Working Area Project	Electric	SEC	Contractor	Contractor				X
Workin Area Installation	Contractor	Municipality of Quilleco	Contractor	Contractor			X	
Entrance Magazine installation	Powder	Municipality of Quilleco	Contractor	Contractor			X	
Autorization of Magazine installation by private land owner	Powder	Owner Ms. Maria Rodriguez	Contractor	Contractor			X	
Exit Magazine Installation	Powder	Municipality of Quilleco	Contractor	Contractor			X	
Authorization for Explosive Consumption		Ejército de Chile	Contractor	Contractor	Res. A.F. 063L.A.9080/04, valid until March 31		X	

Permissions, Authorization and/or Sectorial Commitments						
Description	Competent Authority	Responsibility		Observations	Status	
		Preparation	Presentation		Approval	Started
Authorization for Explosive Transport	Ejército de Chile	Contractor	Contractor	Autoriza vehículo XP 8371 con capacidad de 1.750 Kg. Valida al 31 de Marzo 2006	X	
Domestic Waste Remmoval Agreement	Municipality of Tucapel	Contractor	Contractor	Defines remmoval timings	X	
Authorization for Channel Water Use	Laja Channel Association	Contractor	Contractor	Autohorizes extraction of 30.000 lt. From principal channel	X	
Chemical Treatment Certificate	Toilet Subcontractor	Contractor	Contractor	Discharge agreement between DISAL and ESSBIO	X	
Polliclinic Installation	Health Service Bio Bio	Contractor	Contractor	Pending. Letter of Request	X	
Sanitization and Rat Control	Rat Subcontractor	Contractor	Contractor	Programm Certification by Inducasas Ltda..	X	
Arid Deposit 1 Powder Magazine Authorization and Explosive Use Authorization	Ejército de Chile	Contractor	Contractor	Resolución A.F.063 L.A.9080/43. Valid until 31 de Marzo 2006	X	
Authorization for Arid Extraction from Laja River Bed	Hydraulic Works Direction	Contractor	Contractor	ORD. DOH VIII N° 0909	X	

## Environmental Baseline

### Site Description

The Quilleco run-of-river hydroelectric project will use up to 130m<sup>3</sup>/s of the water released from the Rucúe plant which is currently under operation. In fact, the water intake of Quilleco coincides with the point where the water discharge structure of Rucúe is now located. The water intake channels, aqueduct tunnel, penstocks, power house, and discharge channel of the Quilleco project are located along a land strip of about 8 km that is located on the bank of a South branch of the Laja River. Currently, that land strip and associated branch of Laja River is not influenced by the operation of the Rucúe plant but it will be affected by the construction and operation of the Quilleco project. Consequently, the environmental baseline of the Quilleco project has to be construed in combination with the area of influence of the Rucúe project.

The area of influence of the Quilleco project consists of a complex system of branches of the Laja River. Downstream of the future water discharge point of the Quilleco project, the water flow of Laja River south branch increases with inflows from tributaries of the Northern branch of the river and water springs located along both riversides (Figure A.8). Three irrigation channels operate downstream of the Quilleco's area of influence.

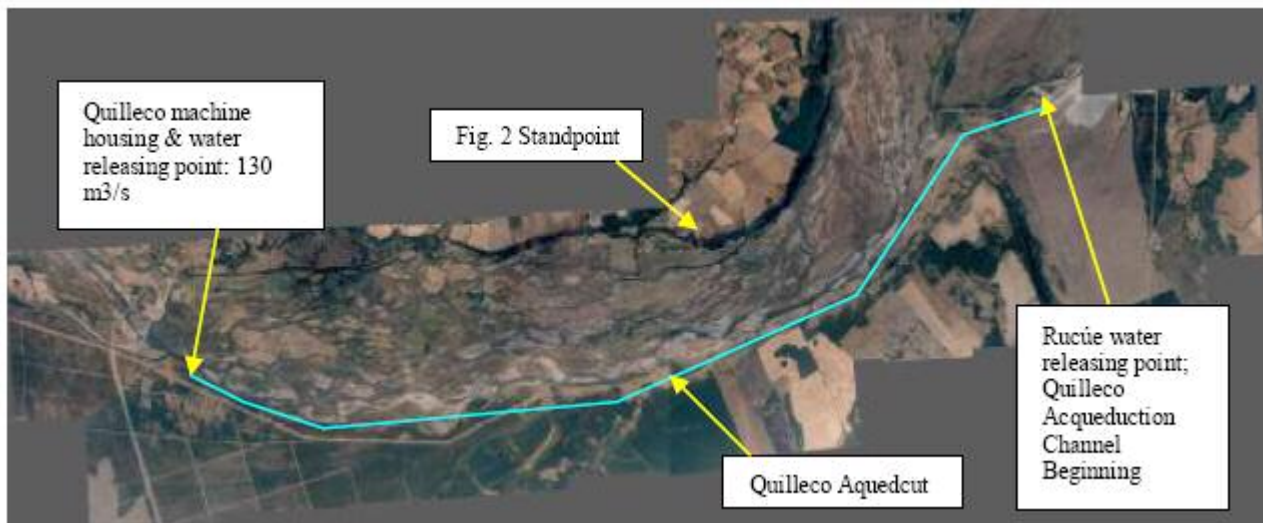
The river bed has a width ranging from 1 to 2 km. It consists of alluvial deposits of volcanic origin where abundant plants and pastures have developed. The South bank of the river has a craggy morphology with no easy access along the area of influence of the project. The North bank of the river consists of craggy and flat segments. The latter are used by several families for domestic farming and small scale commercial farming such as growing cherry trees and stockbreeding.

## Water Quality

Run-of-river projects are considered benign to water quality. No major changes in water quality are expected from the operation of the Quilleco plant. For the construction phase, every single potential water pollutant was identified in the EIA and specific and suitable control measures to avoid underground and river water pollution were assessed and approved by the local environmental authority. The EIA established that water in the area of influence has in general a good quality considering requirements for irrigation, recreation, aquatic life and drinking purposes. No sewage discharges were observed. Variations in water parameters such as conductivity, dissolved solids and chlorine are caused by seasonal fluctuations of river flow only. Several river branches, mainly near the North shore, present low water level particularly in March due to low natural flow. Although water quality could be affected only during the project construction phase, systematic monitoring of chemical and physical parameters of river water is contemplated for both the Rucúe and Quilleco projects.

### Figure A.8 Site Description

#### Aerial view



#### View of the project site from the North bank of the Laja River





## **Zoobentos**

54 aquatic species of zoobentos were found in the area of influence, most of them insects. There is no classification according to protection degrees for any of the species identified. Nevertheless the recovery capacity of local zoobentos communities (and their habitats) is well defined in the academic literature. This is easy to understand, considering seasonal changes in the river natural water flow.

## **Fish**

Eight fish species were identified, 6 of them native. Most important species (in number) are *T. areolatus*, *P. trucha*, *B. australis*, *C. galusdae*, *O. mykiss*, *P. irwini* and *D. nahuelbutaensis*. Species population does not vary over the year. Relative population is large downstream of the area of influence. Two species are in danger of extinction (*Percilia irwini* and *Diplomystes nahuelbutaensis*), while five other species are classified as vulnerable (*T. areolatus*, *P. trucha*, *B. australis*, *C. galusdae* and *O. mykiss*). A comprehensive description of fish population, habitats, sensitivity and even genetic variability studies (for local fish species) can be found in the project documentation.

## **Flora**

62 species were identified. Native flora degradation was observed and associated to plantation of exotic species for agriculture and forestry use, that cover about 13% of the area of influence. According to information from the forestry authority, in the commune of Quilleco, 3.6 % of the land is covered by native forest and another 3.1% by forest plantations.

## **Fauna**

23 species were found to be under some degree of protection and 8 of them are classified as vulnerable (six reptiles, one bird and one mammal). Natural habitats for fauna are very limited and showing some degradation and fragmentation caused by forestry and agricultural activities.

## **Landscape Value**

Three levels of fragility were defined based on landscape quality and visibility of the sites. Six sites were found to be extremely fragile, four were considered as medium and three with low fragility.

## **Soil Use and Soil Use Potential**

The area of influence consists of soils with very limited capacity of use (type VII: 42.5%, type VIII: 27%, type IV: 26.4% and type VI 4.1%). Their principal potential corresponds to forest, livestock and recreational activities, principally fishing. Soils are thin and stony with varying slopes. About 37% of the area is currently covered with native vegetation, 30.3% is covered with forest plantations, 26.9% is used for livestock and 5.7% is used for agriculture.

## Site Sensitivity

Site sensitivity can be classified as low to medium. The EIA considers a significant impact on aquatic fauna, due to change of habitat conditions associated to reduction of water flow in an 8 km segment of the natural river bed. The EIA established that the Quilleco project must supply a minimum ecological flow of  $6\text{m}^3/\text{s}$  to the South river branch during project operation. From the point of view of a river system consisting of several branches, and according to a perception of Tucapel's community, flow reduction in the Southern branch caused by the  $130\text{m}^3/\text{s}$  of water to be taken by the Quilleco project could generate permanent or temporary drought of other smaller river branches existing before the point where the Rucúe plant will discharge that water to the river. Temporary drought of such river branches may have an important impact on aquatic fauna since populations of fishes and benthonic species contained in those branches would get trapped and die systematically. This effect was already observed for the Rucúe project, and replacement of fish and other species had to be made in order to reduce ecological impact. Also, a permanent drought of North river branches could affect water and pasture supply for about 25 families, living currently from micro scale farming (principally cherry trees) and stockbreeding. These concerns of the Tucapel community led to a suspension of the EIA process by Colbún S.A. that contracted EULA of Concepcion University to assess these particular issues. EULA did a comprehensive study of local hydrogeology and determined the  $6\text{m}^3/\text{s}$  Minimum Ecological Flow (MEF) for the Quilleco project at its water intake point. The study also indicated that underground water reserves are balanced between the water input provided by both rains and upstream infiltration of river water, and the water output from downstream water springs and water coming to the surface directly to the river bed. The study concluded that there was not enough information to establish the relative significance of those water sources. However, the obvious fluctuation of water levels in water wells, springs and river branches located over the North river bank after the water taken by the existing Rucúe plant (upstream of the Quilleco project), suggests a significant contribution of upstream river to underground water in the area of influence of the Rucúe project.

Quilleco's EIA was approved in December 2000 as COREMA was technically convinced that with the established MEF the project would not impact the ecosystem or the distribution of river branches. Irrigation channels are not affected by the project, since they operate downstream of the area of influence. The project will not produce large impacts on landscape value. Regarding social aspects, the project will not generate involuntary resettlements, it will create employment during the construction and operation periods, and no indigenous people will be affected.

All comments received during the EIA consultation process were assessed and addressed by Colbún and officially cleared by COREMA in a meticulous way including those generated by lack of public information. Suitable mitigation, reparation and compensation measures are considered for minor impacts on life quality and economic activities during construction and operation phases, particularly related to farming activities. Protection of livestock from stress generated by use of explosives during tunnel construction was not considered relevant, since operation will be executed away from permanent grazing areas.

Concern about generation of electromagnetic fields by the short additional 300m of electric lines and its impacts on animals has no solid scientific background, according to COREMA. Radiation

from lines at ground level is considered low. No residences will be located less than 60m of lines and there is a 32m wide exclusion strip under the line.

## **Environmental Impacts**

Environmental and social impacts were assessed in the EIA, separating baseline elements and project activities, to which different values of probable relevance by extension, intensity and reversibility were assigned. Five categories of impacts were established with the following results:

### **Very Significant Impacts:**

- Modification of fish and zoobentos habitats along 8 km of river system.

### **Significant Impacts:**

- Modification of hydrological regime due to flow reduction along 8 km of river system.

### **Medium Significance Impacts:**

- + Increase of employment due to hiring for construction phase.
- Alteration of water quality during plant operation.

### **Minor Significance Impacts:**

- + Increase of levels of education/instruction due to training of personnel during construction phase.
- + Increase in demand for basic services during construction.
- + Increase in employment during plant operation.
- Modification of sedimentary balance along 8 km of river system.
- Modification of terrestrial habitats of river shore due to flow reduction along 8 km of river system.
- Modification of terrestrial habitats due to aqueduct construction and operation.
- Increased use of roads/streets during construction phase.
- Modification of terrestrial habitats due to excavations, terrain cuts and embankments during construction phase.
- Landscape alteration due to excavations, terrain cuts and embankments during construction phase.
- Landscape alteration due to aqueduct construction/operation.
- Landscape alteration due to natural flow reduction along 8 km of river system.
- Landscape alteration due to working installations.
- Landscape alteration due to power house during operation.

### **Impacts with No Significance:**

- Modification of sedimentary erosive balance due to water replacement works.
- Interruption of territorial continuity due to aqueduct.
- Modification of terrestrial habitats due to de-vegetation and deforestation during construction phase.
- Interruption of territorial continuity due to excavations, cuts and embankments during construction.
- Modification of terrestrial habitats due to working installations during construction phase.
- Temporary dust emissions during construction phase.
- Increased noise and vibration levels during construction phase.
- Modification of terrestrial habitats due to operation of power plant.
- Modification of current or potential soil use due to aqueduct construction/operation.

- Modification of current or potential soil use due to power house.
- Modification of current or potential soil use due to excavations, cuts and embankments during construction phase.
- Modification of terrestrial habitats due to solid waste during construction.
- Modification of terrestrial habitats due to liquid waste during construction.
- Air quality damage due to combustion gases during construction.
- Modification of current or potential soil use due to access ways construction during construction phase.
- Modification of current or potential soil use due to working installations during construction phase.
- Alteration of recreational activities due to working installations during construction phase.
- Alteration of sites with archaeological value due to excavations during construction phase.
- Modification of current or potential soil use due to dump sites.
- Air quality damage due to temporary dust emissions during plant operation.

### **Construction Impacts**

Construction impacts include production of garbage, solid waste, liquid waste, sewage and noise. Production of solid waste from tunnel construction is the largest impact. Every single impact was analyzed thoroughly by the environmental authority, and specific commitments were established for Colbún S.A. in the environmental monitoring plan (see below).

Mitigation measures for the construction phase are clearly defined for every single impact on air quality, noise, and liquid waste (including treatment) from the beginning of the project construction. For solid waste from tunnel construction, dump sites were authorized after a detailed analysis of alternatives. Their location, capacity and area are clearly established in the EIA. Specific conditions for dump sites access, signaling, covering with organic soil and closing are also part of the EIA commitments.

Protection measures against cutting, burning and any unnecessary intervention on vulnerable flora are supervised by a specialist during construction phase. Special emphasis is given to species under some degree of protection.

A reforestation plan was approved by COREMA. The plan includes recovery of land and planting of trees to compensate for trees cut during construction phase, together with reforestation follow-up measures. Plantation and transplantation measures are included for some species. Rescue, relocation and habitat protection measures for flora and fauna are defined in the EIA for the construction and operation phases, with emphasis on species under protection. Furthermore, the EIA includes specific measures for protection of soil and natural water courses, transport of materials and equipment, and risk and emergency control - specially fire and spills.

During operation, impacts will be significantly less than during construction. Sewage will be treated in a suitable treatment plant. Garbage will be stored adequately and disposed of systematically according to law. There will be specific procedures in case of fire or spills.

Table A.16 below summarizes the main potential environmental and social impacts of the Quilleco project.

**Table A.16: Main potential environmental and social impacts**

	<b>Magnitude</b>	<b>Comments</b>
<b>Environmental</b>		
Increased erosion	Low	No destruction of the vegetative cover is expected, therefore this impact will be very minor. Special measures against erosion are considered for dump site construction as well as for water reservoir.
Deterioration of the landscape	Low	There will be no major alteration of landscape once the project is completed.
Air emissions	Low	Very little impact is expected from the diesel generators to be used during construction. Measures for dust control, especially for transport of materials are included in the EIA.
Noise generation	Low	Impact generated by traffic increase and use of explosives during tunnel construction works
Loss of vegetation and biodiversity	Low	No relevant impact is expected, since a minimum ecological flow will be ensured and re-vegetation measures are being applied. Few fish species under some degree of protection were identified and suitable measures for monitoring and recovery were defined.
Loss of agricultural area	Low	The project will not cause any loss of agricultural areas.
Lack of water for biological functions in the river	Low	A Minimum Ecological Flow (MEF) of 6m <sup>3</sup> /s to be maintained at all times in a sensitive 2 km stretch of the Laja River.
Fish species in Laja River	Low	Protective measures are included in the EIA
<b>Social</b>		
Employment generation	High (+)	Significant employment generation during project construction, as well as positive impact on local service activities.
Archeological sites	Low	Specific measures are included in the EIA in case of archeological findings.

### **Environmental Management Commitments**

The EIA resolution contains the following main environmental commitments to be complied with by Colbún S.A. and its contractors.

#### **a) Fauna**

- To mitigate impacts on aquatic fauna, water and terrestrial fauna, Colbún S.A. must maintain a Minimum Ecological Flow (MEF) of 6m<sup>3</sup>/s in the South branch of the Laja river along 2km starting from the point where the Quilleco project water intake from the Rucúe channel.

Downstream of this point, the environmental authority expects a flow of 13m<sup>3</sup>/s in the same river branch, but it is not specified whether Colbún must maintain this flow as MEF (the project area of influence involves 8 km of river system).

#### **b) Flora**

- For tree-covered areas to be affected by works, sponsor has to plant native trees, with a minimum density of 1 tree/10m<sup>2</sup> and a minimum layer of vegetal soil for each tree to be planted. Species to be used are specified in the EIA resolution.
- For pastures and bush areas to be affected by the project, Colbún S.A. will replant with native species including a minimum layer of vegetal soil.
- Local trees and bush species will be planted on slopes, embankments and working areas associated to the project according to an established plan.

#### **c) Solid Waste and Soil Protection**

- Dump sites must be covered with 0.15 m of vegetal soil.
- Colbún will maximize the use of existing roads and minimize construction of new access ways.

#### **d) Liquid Waste and Water Protection**

- Colbún must establish decantation pools for liquid waste during construction phase.

#### **e) Garbage**

- Garbage storage, transport and disposal are well defined in the EIA, under the supervision of Health Services.

#### **f) Sewage**

- Health Services will supervise treatment and disposal of sewage. Three treatment plants are established for the construction phase.

#### **g) Landscape Value**

- In order to mitigate landscape impacts, the sponsor must implement re-vegetation and reforestation on exposed soils (slopes and embankments).
- The EIA resolution specifies surface treatment (topography, upper layer) and tree species to be used for revegetation of dump sites.
- Colbún S.A. has to consider the following criteria for modeling dump sites:
  - Avoid topographic elements that denote artificiality
  - Respect natural topographic scales
  - Occult unavoidable visual impacts
  - Use vegetation in order to harmonize landscape

#### **h) Minimal Ecological Flow (MEF)**

The Minimal Ecological Flow (MEF) is the most important environmental measure for the project operation phase. The MEF was defined by EULA in October 2002, approved by COREMA and included in the Environmental Qualification Resolution (December 2000). The conservative In-stream Flow Increase Methodology (IFIM) was used by EULA for the first time in Chile for MEF determination. Criteria of this methodology include landscape, habitat and biodiversity (algae, invertebrates and fish) conservation. Special emphasis was given in this case to avoid the extinction of endangered fish species (*D. nahuelbutaensis* and *P. irwini*) and vulnerable species (*T. areolatus*, *P. trucha*, *B. australis*, *C. galusdae* and *O. mykiss*). *O. mykiss* and *P. trucha* are introduced fish species, but they have economic value associated to fishing activities.

The MEF will be monitored at three points within the area of influence of the project, as recommended by EULA: (i) the South branch of the Laja River on a critical stretch of 2 km will be monitored via remote signal in order to generate hourly data; (ii) the Laja River before the Rucúe confluence will be monitored twice a year for 5 years; (iii) the Laja River after the Rucúe confluence in front of the Quilleco aqueduct channel will be monitored twice a year for 5 years. Even though these monitoring measures are only recommendations from EULA, Colbún S.A. has committed to their full implementation as monitoring procedures for Quilleco's operation. Table A.17 indicates the MEF values established by EULA and approved by COREMA. These values are included in the EIA Resolution.

**Table A.17 Minimum Ecological Flow of the Laja River within Quilleco's area of influence**

<b>River Section or Branch</b>	<b>MEF</b>
Laja River before water discharge of Rucúe	> 17 m <sup>3</sup> /s
Laja River after water discharge of Rucúe (South branch included) until Quilleco water discharge point	> 17 m <sup>3</sup> /s
South Branch of Laja River between confluence of Rucúe River and a zone of 2 km downstream	> 6 m <sup>3</sup> /s
South Branch of Laja River, downstream of previous section	> 13 m <sup>3</sup> /s

Source: EULA; EIA.

#### **i) Natural Habitats**

Through the MEF, Colbún S.A. ensures:

- Conservation of landscape structure of the river system in the critical zone.
- Habitat conservation for all existing species.
- Conservation of biodiversity of all species (micro algae, primary consumers and superior consumers).
- Increase of habitat usable surface for permanent and temporary species.
- Permanence of species under extinction risk (*Diplomystes nehuelbutensis* and *Percilia irwini*), as well as of vulnerable species (*Trichomycterus areolatus*, *Percichtys trucha*, *Bailichthys australis* and *Cheirodon galusdae*).
- Permanence of economically most important species: *Onchorhynchus mykiss*.

#### **EIA Monitoring Plan**

Colbún S.A. will implement a monitoring plan in order to measure and assess the project's effects on water quality for aquatic species, biodiversity and hydro-biological resources under the following conditions and requirements:

##### **a) Aquatic Habitat**

- Systematic monitoring of aquatic fauna at 4 points along 8 km of the Laja River affected by the project, 3 to 4 days in February, July and December for 5 years.
- Colbún will take actions in order to maintain quantity and quality of hydro-biological communities in the area of influence during project operation.

##### **b) River Water Quality and Quantity**

- Systematic monitoring of water quality (33 parameters) at 4 points along 8 km of the Laja River affected by the project, 3 to 4 days in February and November during 5 years.
- Flow control of the Laja River at Laja-Rucúe union, daily, for project life.

- Recommendations of EULA regarding monitoring frequency of MEF will be fully implemented (see Table A.18).

**Table A.18 Monitoring of Minimum Ecological Flow**

<b>River Section or Branch</b>	<b>Monitoring Frequency</b>	<b>Monitoring Period</b>
South Branch of Laja River within critical stretch of 2 km	Hourly (remote monitoring)	Project lifetime
Laja River before Rucúe confluence	Twice a year	5 years
Laja River after Rucúe confluence until Quilleco water release	Twice a year	5 years

**c) Flora and Vegetation**

Detect and record structural changes (vertical and horizontal) in vegetation as well as development stage and presence of parasites due to the project with respect to baseline.

**d) Independent Environmental Audits**

Independent environmental audit during construction phase and before operation, with previous agreement of COREMA regarding the audit Terms of Reference, in order to:

- Control fulfillment of legal requirements.
- Control fulfillment of mitigation, reparation and compensation commitments.
- Control fulfillment of monitoring and contingency plans.
- Control fulfillment of general requirements established by environmental authorities in the EIA resolution.
- Detect impacts not considered in the EIA.
- Assess suitability of measures, risks, contingencies or other effects not considered in the EIA.
- Inform authorities about environmental impacts and management.
- Verify that copies of permits/approvals by any authority were sent to COREMA within 10 days from the approval date.

After a period of 5 years, the results of the monitoring plan will be assessed in order to enhance its scope and methodologies for the next period, with prior approval by competent authorities.

Results of the monitoring plan will be submitted to COREMA and relevant authorities in the form of reports on all activities and commitments. All data and actions will be informed to COREMA within 24 hours after detection/action. Changes in the monitoring plan will be informed to relevant authorities and no change will be implemented before approval by COREMA. Colbún S.A. will construct a monitoring station downstream of the Rucúe discharge channel.



### **Risk Management Plan**

Colbún will implement a risk management plan in order to identify, analyze and propose measures to prevent incidence of potential risks of project works and activities, including impacts of possible natural processes like earthquakes and volcanic activity. The following works and activities are taken into consideration:

- Water Intake Works
- Aqueduct Channel
- Aqueduct Tunnel
- Charging Chamber
- Penstocks
- Power House
- Releasing Channel
- Transmission Line
- Dump sites
- Fuel and Lubricant Storage

### **Contingency Plan**

Colbún S.A. will implement a contingency plan with actions and measures associated to potential accidents during all phases of the project.

## **11. Social Analysis (Risk Level: LOW)**

### **Social Setting Baseline**

The area of social analysis comprises the communes of Quilleco and Tucapel. The commune of Quilleco is defined as the area of direct influence of the project because the project is located in this commune, and the neighbor commune Tucapel is defined as the area of indirect influence. Both communes have similar characteristics from a socioeconomic point of view: high levels of rural population, unemployment and poverty – compared to national average, with economic activities related to forestry, stockbreeding, informal fishing and some agriculture. The use of soil in the area of influence of the project is of four types: native vegetation (37.1 %), forest (30.3 %), cattle breeding (26.9 %) and agriculture (5.7 %).

Direct Influence Area: This area is owned by 5 land owners, and it is used to develop mainly forestry and agricultural activities. There are no housings that could be directly affected during the construction and operation of the project. The commune of Quilleco has approximately 10,000 inhabitants, of which approximately 3,700 are urban and the rest are rural. Inhabitants of the commune perceive that their economy has been quite depressed lately, and that poverty is significant (see Table A.19), which is why they have showed a strong support towards the project as they expect the Quilleco project to become a future source of jobs.

**Table A.19 Poverty levels in the Quilleco commune**

	Number of people	Commune (%)	National average (%)
Poor (Not indigent)	2,120	21.84	14.89
Poor (Indigent)	1,269	13.07	5.73

Source: MIDEPLAN (2002)

**Indirect Influence Area:** This area is on the northern shore of the Laja River branches. It is used by some Tucapel people as a water and land source to carry out economic activities. Some people living on the Northern shore (about 25 families) claim to be affected by the operation of the Rucúe plant, because of a decrease of water levels in river branches and in water wells. Drying out of some Northern river branches has been visually confirmed (Figure A.9). These people are afraid of a further reduction in water resources and pastures associated to a decrease of soil humidity. It is important to point out that although the Tucapel community assumes that the Quilleco project will be completed, those of their concerns that are legitimate need to be taken into consideration.

The commune of Tucapel has approximately 12,000 inhabitants and its principal economic activities are also forestry, fishing and cattle breeding. Informal fishing is more intensive because access to the river is easier from the Northern shore. The poverty indicators of Tucapel are similar to those of its neighbor commune (Table A.20). Inhabitants of Tucapel were less supportive of the project than Quilleco's population, because of concerns from the families living on the Northern shore of the river regarding water availability from the river.

**Table A.20 Poverty levels in the Tucapel commune**

	Number of people	Commune (%)	National average (%)
Poor (Not indigent)	3,592	26.91	14.89
Poor (Indigent)	1,210	9.7	5.73

Source: MIDEPLAN (2002)

**Consultation:** Social consultation was conducted during the EIA through announcements in local newspapers and workshops attended by representatives of the local community of Quilleco, in accordance with the EIA System established by the Chilean law (*Ley 19.300 and Decreto Supremo 95*). All objections and questions posed by the Quilleco community were assessed and addressed by Colbún and officially cleared by the local environmental authority (COREMA) in a meticulous way.

### **Social Impacts**

**Direct Influence Area:** In the commune of Quilleco, the EIA identified a moderately significant (positive) impact of the project due to the creation of the employment during the construction phase. No significant impacts of negative character were identified in the EIA. This can be explained because the use of the soil in this area is mainly for forest exploitation and there are no significant cattle or agricultural activities, with the exception of isolated cases of stockbreeding.

**Indirect Influence Area:** At the time the EIA was done in 1999, the Tucapel municipal authorities showed a strong opposition to the project. The current municipal authorities have shown a moderate reticence, mainly to support the concerns of families that claim to have been affected by operation of the Rucúe plant regarding water availability. Recreational activities would have been specially affected with the operation of Rucúe plant: a zone in the Northern branch of the river, where a bathing place was located, is now completely dry. Increased fruit-bearing tree mortality (mainly cherry trees), decrease of water level in wells and drought of some wetlands has been observed. Stockbreeding activities apparently were also affected by a decrease of

available pastures. Consequently, a legitimate concern exists about a possible further decrease in water availability and its effects on cattle and agricultural activities. Colbún S.A. recognizes these facts but it imputes them to natural climate changes during the construction and operation of the Rucúe plant, an assumption that seems to be corroborated by the EULA study. Hence, it is for Colbún S.A. to technically demonstrate and explain to the population that the changes observed in water levels are independent from the construction and operation of the Rucúe project and that the construction and operation of the Quilleco project will not worsen the situation. This is particularly relevant for about 25 families of Tucapel commune living almost on top of the river bed of the North bank of the Laja River.

### **Social Commitments**

There is evidence of the positive attitude of Colbún S.A. to consider and assess the concerns of local communities. According to its internal reports, Colbún S.A. maintains good relations with the community and their authorities and agreed to: (i) support the hiring of local manpower in both communes for the construction of the project through a registration process managed by the municipalities of Quilleco and Tucapel; (ii) support the permanent training of 10 % of workers contracted during the 3-year construction period of the project, generating a strong positive impact; and (iii) include the social variable as part of the independent environmental audit during the construction and operation of the project. Moreover, in May 2005, Colbún S.A. sent a heavily documented response to representatives of the commune of Tucapel covering all their social and environmental concerns raised on behalf of the community and, lately, a second letter stating that Colbún S.A. considers that all their concerns have been addressed since no feed back was received from them. Personal contacts and simple communications means would be the appropriate instruments to use in cases like this when the significant asymmetry of knowledge and information existing between the professional staff of Colbún and the people of Tucapel might explain the absence of response of the latter.

### **Summary of Environmental and Social Measures**

The main social and environmental measures included in the EIA are summarized in Table A.21 below, including identification of timing and responsibility of application.

**Table A.21: Summary of social and environmental measures**

<b>Program/Activity</b>	<b>Responsibility</b>	<b>Timing/Schedule</b>
Periodic independent environmental audits	Colbún	Started prior to construction and will continue throughout project life
Organization/filing of technical and environmental documentation	Colbún	Prior to construction
Proper construction waste disposal	Colbún/Contractor	Identification of dump sites by sponsor prior to bidding  Use of designated dump sites by contractor during construction
Air emission control	Colbún/Contractor	During Construction
Proper liquid waste treatment	Colbún/Contractor	During Construction
Noise generation and warning of use of explosives	Colbún/Contractor	During Construction of Tunnels
Proper solid waste (including soil) storage and disposal	Contractor	During construction
Proper Dump Construction and Closing	Colbún/Contractor	During Construction
Designation and use of areas for hazardous waste confinement (oils, chemicals, etc.); proper waste disposal including a monthly inventory of used substances, storage in metal containers, and disposal at appropriate sites.	Contractor	During Construction
Designation of boundaries of work zone (to protect areas beyond these boundaries)	Colbún/Contractor	During Construction
Protection of archeological sites	Contractor/Colbún	During Construction
Installation of traffic Signals	Colbún	Prior to Construction Works
Flora and fauna protection and monitoring measures	Colbún/Contractor	During Construction and Operation

Reforestation Plan (including dump sites) and monitoring	Colbún	During Construction
Water quality monitoring program	Colbún	Several measuring points with different frequency of measuring
Contingency plan (including fire and spills)	Colbún	Prior to operation
Maintaining the Minimum Ecological Flow	Colbún	During project construction and operation
Abandonment plan for project works areas	Colbún	Prior to abandonment of works areas

During project appraisal in April 2006, the following additional measures were agreed upon with Colbún regarding social and environmental aspects of the Quilleco project:

- Colbún will send the quarterly reports on environmental and social audits to the Bank.
- The Bank will carry out a mission to evaluate the implementation of the environmental management plan before the end of project construction.
- Colbún will support research and scientific publications on endangered fish species of the Laja River in the area of influence of the Quilleco project.
- Colbún will expedite ongoing measures intended to address the environmental liabilities of Rucúe project.
- Colbún will implement a communication and information plan with the Valle de Laja community on the environmental impacts of Quilleco project and will inform the Bank on the results of this activity.
- Colbún will establish a baseline of the environmental situation in the Valle de Laja community.
- Colbún will support the implementation of small productive and social projects as a contribution to the economic and social development of the area.
- Whenever necessary, Colbún and COREMA will jointly analyze the possibility of establishing a three-party committee (Colbún, COREMA and Communities) as a mechanism to resolve possible conflicts with the communities regarding environment and social aspects.

The above commitments are referred to in the ERPA signed between HGV and the World Bank.

## 12. World Bank Safeguard Policies

The following World Bank Safeguard Policies are triggered by the Quilleco project: environmental assessment, natural habitats and cultural property (see Table A.22).

**Table A.22: Compliance with World Bank Safeguard Policies**

Safeguard Policy	Is Policy triggered? Y/N	Main Environmental and/or Social Issues
Environmental Assessment (OP 4.01)	Y	Those typical of a run-of-river hydropower project.
Forestry (OP 4.36)	N	
Involuntary Resettlement (OD 4.30)	N	
Indigenous Peoples (OD 4.20)	N	
Safety of Dams (OP 4.37)	N	
Pest Management (OP 4.09)	N	
Cultural Property (OPN 11.03)	Y	Possible archeological sites
Natural Habitats (OP 4.04)	Y	Presence of endangered fish species
Projects in Disputed Areas (OP 7.60)	N	
International Waterways (OP 7.50)	N	

### **O.P. 4.01 – Environmental Assessment**

Risk Level: LOW

Site sensitivity to project implementation and operation can be classified as low to medium. Downstream of the influence area of the project, the water flow used for agricultural purposes will not be affected. A minimum ecological flow of 6m<sup>3</sup>/s will be ensured in the sensitive first two kms of the Laja River south branch, downstream from the Quilleco project water intake. Erosion risk is low, since general geomorphology of the influence area is rocky. The project will not cause involuntary resettlement and no indigenous people will be affected. Specific and suitable protection, mitigation and monitoring measures are clearly defined in the approved EIA. Independent monitoring and control of application of the EIA measures is taking place during project construction and will continue during project operation.

### **OP. 4.04 – Natural Habitats**

Risk Level: LOW

Endangered fish species were identified within the area of influence of the project, and protective measures were defined in order to protect its habitats, in particular through application of the minimum ecological flow, which will be subject to monitoring and auditing. During project

appraisal, Colbún committed to support additional activities such as research on fish population management and publications on endangered fish species.

### **OP.11.03 – Cultural property**

Risk level: LOW

With respect to cultural property, one archeological site was found in the area of influence. Protection measures have been implemented for this particular case. This area will not be affected by construction activities or dump sites. Contingency measures for other possible findings are clearly defined in the EIA and local authorities are officially informed. The National Monument Law applies in case of other findings: sponsor must stop works immediately and inform local authorities about findings, who will assess each finding on a case by case basis. The probability of further findings seems low.

### **13. Project processing**

EIA to InfoShop:	September 20, 2004
QER review:	February 16, 2006
Appraisal departure:	April 3, 2006
PAD approval by CMU:	April 24, 2006
Signing of ERPA:	June 2006
Project construction began:	December, 2005
Project commissioning:	September 2007
First Payment for ER:	2008

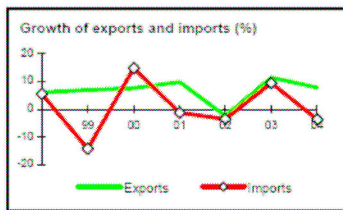
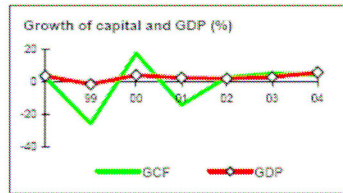
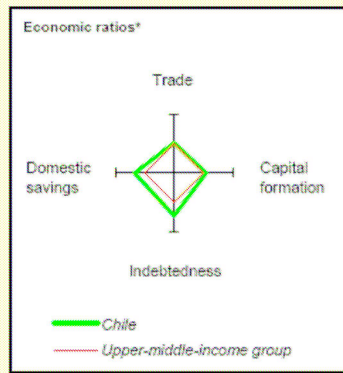
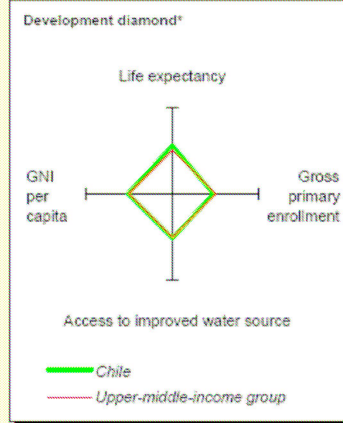
### **14. Documents in the project file**

1. Chile - Power Sector Baseline Study
2. Chile – Power Sector Monitoring Protocol
3. Quilleco PDD
4. Quilleco PIN
5. Quilleco PCN
6. Quilleco Letter of Intent
7. Quilleco Letter of Approval
8. Quilleco ERPA (to be signed, confidential)
9. Quilleco Feasibility Study
10. Financial Analysis
11. Quilleco Environmental Impact Assessment (EIA)
12. Environmental Qualification Resolution (Resolución de Calificación Ambiental, RCA)
13. Evaluación Socioambiental del proyecto de Quilleco (M. Fadda & P. Hevia, Consultores)
14. Quilleco Term Sheet
15. Quilleco - QER comments
16. Quilleco ISDS

# Chile at a glance

8/25/05

	Chile	Latin America & Carib.	Upper-middle-income		
<b>POVERTY and SOCIAL</b>					
2004					
Population, mid-year (millions)	16.0	541	576		
GNI per capita (Atlas method, US\$)	4,910	3,600	4,770		
GNI (Atlas method, US\$ billions)	78.3	1,948	2,748		
<b>Average annual growth, 1998-04</b>					
Population (%)	1.2	1.4	0.8		
Labor force (%)	2.0	0.9	-0.9		
<b>Most recent estimate (latest year available, 1998-04)</b>					
Poverty (% of population below national poverty line)	17	..	..		
Urban population (% of total population)	87	77	72		
Life expectancy at birth (years)	76	71	69		
Infant mortality (per 1,000 live births)	8	28	24		
Child malnutrition (% of children under 5)	1	..	..		
Access to an improved water source (% of population)	95	89	93		
Literacy (% of population age 15+)	96	89	91		
Gross primary enrollment (% of school-age population)	100	123	106		
Male	101	126	108		
Female	99	122	106		
<b>KEY ECONOMIC RATIOS and LONG-TERM TRENDS</b>					
	1984	1994	2003	2004	
GDP (US\$ billions)	19.2	50.9	72.4	94.1	
Gross capital formation/GDP	13.7	24.1	24.2	23.4	
Exports of goods and services/GDP	24.2	29.3	35.7	36.3	
Gross domestic savings/GDP	12.6	25.4	27.3	30.1	
Gross national savings/GDP	2.3	21.1	23.4	15.4	
Current account balance/GDP	..	-3.1	-0.8	-1.8	
Interest payments/GDP	10.3	1.8	1.8	1.4	
Total debt/GDP	102.6	43.5	59.8	46.8	
Total debt service/exports	..	18.9	30.5	27.6	
Present value of debt/GDP	..	..	61.0	..	
Present value of debt/exports	..	..	167.2	..	
	1984-94	1994-04	2003	2004	2004-08
<i>(average annual growth)</i>					
GDP	7.5	3.9	3.3	6.1	4.0
GDP per capita	5.8	2.6	2.1	4.9	3.0
Exports of goods and services	10.6	7.4	11.4	7.7	1.7
<b>STRUCTURE of the ECONOMY</b>					
	1984	1994	2003	2004	
<i>(% of GDP)</i>					
Agriculture	7.5	9.4	8.8	8.9	
Industry	40.5	35.6	34.3	34.5	
Manufacturing	24.2	18.4	15.8	15.9	
Services	52.0	55.0	56.9	56.6	
Household final consumption expenditure	73.0	64.6	60.7	57.9	
General gov't final consumption expenditure	14.5	9.9	12.0	12.0	
Imports of goods and services	25.3	28.0	32.6	29.6	
	1984-94	1994-04	2003	2004	
<i>(average annual growth)</i>					
Agriculture	6.1	3.0	3.3	6.1	
Industry	6.3	3.9	3.3	6.1	
Manufacturing	6.6	2.2	3.3	6.1	
Services	7.1	3.9	3.3	6.1	
Household final consumption expenditure	7.3	3.1	1.0	-2.4	
General gov't final consumption expenditure	2.4	4.3	4.8	11.8	
Gross capital formation	13.9	0.7	5.5	4.5	
Imports of goods and services	12.6	3.8	9.3	-3.7	



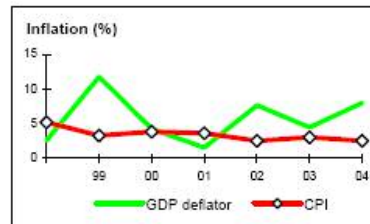
Note: 2004 data are preliminary estimates.

\* The diamonds show four key indicators in the country (in bold) compared with its income-group average. If data are missing, the diamond will be incomplete.



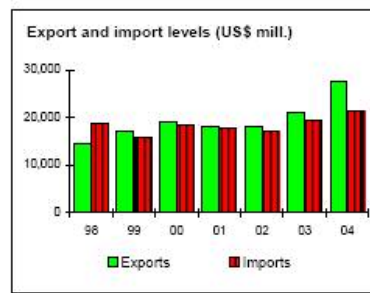
## PRICES and GOVERNMENT FINANCE

	1984	1994	2003	2004
<b>Domestic prices</b>				
(% change)				
Consumer prices	19.9	11.4	3.0	2.5
Implicit GDP deflator	12.6	12.6	4.4	8.0
<b>Government finance</b>				
(% of GDP, includes current grants)				
Current revenue	..	22.5	21.4	22.5
Current budget balance	..	4.8	3.0	4.5
Overall surplus/deficit	..	1.7	-0.4	1.3



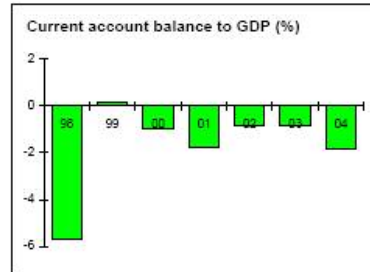
## TRADE

	1984	1994	2003	2004
(US\$ millions)				
Total exports (fob)	3,651	11,604	21,046	27,600
Copper	1,604	4,242	7,503	12,004
Fruits	428	976	1,678	2,440
Manufactures	1,260	5,115	8,813	11,557
Total imports (cif)	3,654	11,820	19,413	21,400
Food	481	..	..	..
Fuel and energy	595	1,141	3,100	3,418
Capital goods	573	3,243	5,290	5,831
Export price index (2000=100)	78	104	94	115
Import price index (2000=100)	61	71	99	114
Terms of trade (2000=100)	127	148	95	101



## BALANCE of PAYMENTS

	1984	1994	2003	2004
(US\$ millions)				
Exports of goods and services	..	14,444	25,851	34,123
Imports of goods and services	..	13,861	23,602	27,851
Resource balance	..	583	2,249	6,272
Net income	..	-2,499	-3,280	-2,296
Net current transfers	..	331	438	-5,715
Current account balance	..	-1,585	-594	-1,739
Financing items (net)	..	4,779	959	1,462
Changes in net reserves	..	-3,194	-366	277
<b>Memo:</b>				
Reserves including gold (US\$ millions)	..	13,467	15,342	15,066
Conversion rate (DEC, local/US\$)	98.5	420.2	691.4	609.5



## EXTERNAL DEBT and RESOURCE FLOWS

	1984	1994	2003	2004
(US\$ millions)				
Total debt outstanding and disbursed	19,737	22,155	43,308	44,058
IBRD	214	1,919	422	441
IDA	18	11	5	5
Total debt service	2,776	2,833	8,063	9,566
IBRD	39	332	208	258
IDA	1	1	1	1
Composition of net resource flows				
Official grants	18	67	23	..
Official creditors	280	-189	-90	-107
Private creditors	927	1,629	353	359
Foreign direct investment (net inflows)	78	2,583	2,982	..
Portfolio equity (net inflows)	0	1,259	312	..
World Bank program				
Commitments	136	10	25	211
Disbursements	40	81	38	259
Principal repayments	22	192	173	241
Net flows	18	-112	-136	18
Interest payments	18	140	35	18
Net transfers	1	-252	-171	0

